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ABSTRACT

Data related to current and recent engineering manpower demand, engineering degrees and enrollments, supply and demand projections for engineering manpower, and results of an April 1982 survey of New York's engineering schools are presented and discussed in separate sections of this report. Based on these data, nine recommendations for the future of engineering education in New York State are made. These recommendations address both questions of quantity and quality in engineering programs. A summary (highlighting the data and listing the nine recommendations) and detailed lists of figures and tables are included at the beginning of the report. Recommendations include expanding capacity in undergraduate engineering education; expanding opportunities for part-time graduate education for employed engineers; encouraging industry/university cooperation to alleviate faculty shortage and the problem of obsolete equipment in universities; increasing the number and financial stipends of teaching assistantships; establishing graduate fellowships; funding Centers for Advanced Technology (described in Regents 1982 Legislative Proposals); authorizing equipment acquisition grants and determining dimensions of need for additional instructional/research equipment; and continuing every effort to ensure quality engineering programs in New York. (Author/JN)

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ENGINEERING MANPOWER AND ENGINEERING EDUCATION IN NEW YORK STATE:

A REPORT AND RECOMMENDATIONS FOR ACTION

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The University of the State of New York
THE STATE EDUCATION DEPARTMENT
Albany, New York

ENGINEERING MANPOWER AND ENGINEERING EDUCATION IN NEW YORK STATE: A REPORT AND RECOMMENDATIONS FOR ACTION

JULY 15, 1982

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Principal author of this report is Dr. Celia B. Diamond of the Bureau of Postsecondary Planning.

SUMMARY

Over the past five years, employer demand for engineers has been strong. This fact and the resulting high salary offers to new engineering graduates have had two major effects: (1) undergraduate enrollments in engineering rose an average of 9.6 percent per year nationally between 1976 and 1980; (2) fewer recipients of bachelor's degrees in engineering chose to continue full-time toward graduate degrees. At the present time, despite conflicting projections of engineering manpower demand and mixed signals as to the state of the U.S. economy, it seems likely that demand for engineers will continue to be relatively high, both nationally and in New York State.

The supply of new engineers primarily is the number of people earning degrees each year. The market is a national one; thus, job openings and degrees granted cannot simply be matched within the State to determine whether an unmet demand exists or can be projected. Nationally, the brisk job market and high salary offers for new graduates continue to indicate some shortage of new engineers.

Enrollments in engineering programs have risen at a more rapid rate than have degrees in recent years. There is a limit on enrollments, however; they cannot continue to rise at high rates, for departments of engineering are finding their capacities strained. Fewer doctorates have been awarded recently than in the early 1970's; and industry has been attracting some former faculty members with high salary offers and more modern research equipment than colleges can provide.

In the light of these facts, this report makes nine recommendations for the future of engineering education in New York State. These recommendations address both questions of quantity and questions of quality in engineering programs. If they are followed, the State will be better prepared to meet the needs of its economy and its schools of engineering in the 1980's and 1990's. The recommendations, which are developed fully in the final section, are as follows:

Recommendation 1. *The Regents recommend that New York State expand its capacity in undergraduate engineering education by 5 to 10 percent by 1985.*

Recommendation 2. *The Regents recommend an immediate, limited expansion of opportunities for part-time graduate education for the employed engineer, particularly in areas of high industry concentration.*

Recommendation 3. *The Regents recommend that New York State encourage programs of industry-university cooperation to alleviate both the faculty shortage and the problem of obsolete equipment in engineering colleges.*

Recommendation 4. *The Regents recommend, as one means of making the teaching of engineering a more attractive career, that alternatives to enhance faculty salaries be examined.*

Recommendation 5. *In order to lighten the burden which capacity or above-capacity enrollments are imposing upon engineering faculty members, the State should adopt programs which would increase both the number and the financial stipends of teaching assistantships in engineering schools which offer graduate programs.*

Recommendation 6. *In addition to teaching assistantships, the State should establish a program of substantial graduate fellowships for full-time students in doctoral-level engineering programs.*

Recommendation 7. *Centers for Advanced Technology, described in the Regents 1982 Legisative Proposals, should be authorized by legislation and funded. Each Center would operate within a designated technological field selected by the Regents in consultation with the New York State Science and Technology Foundation and the State's scientific, engineering, industrial, and business communities.*

Recommendation 8. *Research Equipment Acquisition Grants, described in the Regents 1982 Legislative Proposals, should be authorized by legislation and funded. Further, the State should seek to determine the dimensions of the acknowledged need for additional engineering laboratory equipment for both instructional and research purposes and initiate additional programs to help meet that need.*

Recommendation 9. *The Department shall continue its vigorous efforts to ensure the quality of engineering education programs in New York.*

The pages which follow lead to these recommendations by examining the circumstances which confront engineering education in the nation and the State: curent and recent engineering manpower demand, engineering degrees and enrollments, supply and demand projections for engineering manpower, and the results of an April 1982 survey of New York's engineering schools.

Introduction

Titles or texts of recent articles and papers indicate current national concerns about engineering manpower and engineering education:

> "Engineers, approximately 8 percent of graduates, received 65 percent of job offers to bachelor's-degree recipients in 1981."[1]
>
> "Engineering Education: Coping with the Crisis."[2]
>
> "Rising undergraduate enrollments [in engineering] have forced many institutions to limit or even reduce enrollment."[3]

Indeed, as undergraduate enrollments climb steeply, those at the doctoral level remain stable or fall. Faced with a high employer demand for engineers, experts in the field disagree about whether it will remain strong. The current Federal administration seeks to increase appropriations for the national defense, a direction which would increase demand for engineers; at the same time, appropriations to support engineering education would decline. The institutions providing that education, however, face a faculty shortage and a problem of obsolescent laboratory equipment which are causing many to limit enrollments despite a rising number of applications.

At the present time, there are 20 institutions in the State offering one or more accredited programs in engineering, including five campuses of State University, one college of City University, and 14 independent institutions. In 1980-81 they awarded 4,987 bachelor's degrees, 1,836 master's degrees, and 267 doctorates in engineering, a number which placed New York second in the nation in numbers of bachelor's and master's degrees conferred, and third in number of doctorates.

New York institutions share the national problems. Their enrollments, too, are up --so much so that many are putting a cap on future size. Since approximately half of engineering graduates remain in the State for employment, the question has arisen whether the supply of new engineers is sufficient to meet the future needs of New York industry, particularly the high-technology companies which have been identified as a strength upon which to build for the State's future economic development.

Current and Recent Engineering Manpower Demand

In the past five years, employer demand for engineers has been strong. Over the past six months, however, the economy has fallen into a recession, and its depth and duration will necessarily affect demand for engineers. At this moment, the signals are mixed, making manpower projections more than usually difficult.

Employment and Unemployment

The National Science Foundation observed in 1980 (surveying the situation up to 1978) that the unemployment rate for scientists and engineers, lumped together, had fallen from 3 percent in 1976 to 1.4 percent in 1978.[4] Compare the figures for other groups in the table below:

Unemployment Rates for Selected Groups

	1976	1978
All workers age 16 and over	7.7 percent	6.0 percent
Men age 20 and over	5.9 percent	4.2 percent
White-collar workers	4.6 percent	3.5 percent

Source: U.S. Bureau of Labor Statistics

The unemployment rate for engineers averaged 1.2 percent for 1979 and 1.3 percent for 1980; it continued at that level through the first three quarters of 1981, compared with an unemployment rate of 2.8 percent for all professional and technical workers.[5] The U.S. Labor Department's list of "hard-to-fill occupations at Job Service Offices" in late 1978 and early 1979 included electrical, industrial, mechanical, and civil engineer; engineering positions, less than one percent of the jobs listed, were almost 25 percent of the "hard-to-fill" vacancies.[6] Between 1976 and 1978, business and industry (employing 78 percent of all U.S. engineers in 1978) increased their engineer employment almost 3 percent; Federal, state, and local government (employing 14 percent of all engineers) increased engineer employment 11 percent in the same period.[7] According to the NSF, industry's employment

of "full-time equivalent" scientists and engineers in research and development rose to a new high of 470,000 in January 1981 (5 percent higher than the previous year's figure). The total number of scientists and engineers engaged in research and development rose nearly 30 percent between January 1976 and January 1981.[8]

Job offers to new engineering baccalaureates reflected a rapidly rising employer demand through 1981. Each year, Frank S. Endicott and associates at Northwestern University survey business and industrial employers to assess their hiring of new graduates; between 1979 and 1980, employment of engineering baccalaureates increased by 29 percent among 170 companies surveyed, while employment in non-engineering fields increased 6 percent.[9] The College Placement Council conducts a similar annual survey. The 513 industrial, educational, and government employers responding to its June 1981 survey reported hiring 10 percent more bachelor engineers than in 1980 (and 15 percent more with master's degrees, 22 percent more with doctorates).[10]

Preliminary 1982 surveys indicated that demand was still high, but showing some effects of the economic downturn. The Endicott Report for 1982 surveyed 242 major employers nationwide on their hiring plans. All told, the firms planned to hire 21 percent more baccalaureate engineers than they had in 1981, and 28 percent more master's degree recipients. According to a nationwide survey of 3,200 employers by Fox-Morris early in 1982, demand for experienced engineers was up 16 percent.[11] But a U.S. News and World Report survey found such employers as Boeing, Amoco Production Company, General Electric, DuPont, and several major Midwestern firms either holding engineering hiring steady this year, or cutting back.[12] Deutsch, Shea, and Evans, Inc., an advertising firm, publishes a semiannual Employment Level Forecast based on a survey of top employment executives at Fortune 1300 organizations. For the first half of 1982, its December 1981 forecast projected a decline in overall employment at more than one-third of 249 major corporations responding, compared to 17 percent in the previous survey. For engineers and scientists, however, 30 percent of the executives saw employment rising, 41 percent thought it would remain stable, and only 5 percent believed that it would decline.[13]

Salaries

Relative salaries paid in various occupations also provide "a good indicator of market conditions."[14] Each year, the Engineering Manpower Commission (EMC) of the American Association of Engineering Societies conducts a salary survey of engineer employers from all sectors of the economy. Table 1 shows how engineers' salaries increased from 1953 to 1980. To set such figures in perspective, the EMC provides an analysis in terms of 1967 constant dollars (Table 2). The EMC noted that, averaged over the 27 years, 1953-1980, the income in constant dollars for the 1953 starting engineer increased about 6.85 percent per year; starting rates have increased a little more than 2 percent per year, and an engineer starting in 1980 "has in fact 11 percent less in purchasing power" than one starting in 1970.[15]

For purposes of comparison, U.S. Bureau of Labor Statistics figures show that the gross hourly earnings for all non-farm business workers rose by only 0.24 percent per year from 1969 through 1979; those for workers in manufacturing rose by 0.57 percent per year in that period, while the Consumer Price Index (CPI) rose by an average of 7.1 percent per year (Table 3, page 10). As Table 4 (page 11) shows, the median salary for engineers without experience has consistently been higher than the median for all professional and technical workers combined. Thus, although engineers' salaries have not kept up with the CPI, they have done relatively better than the average worker's. Salaries of engineers employed in industry have increased at nearly the same rate as those of all professional and advanced technical workers in private industry (Table 5, page 12).

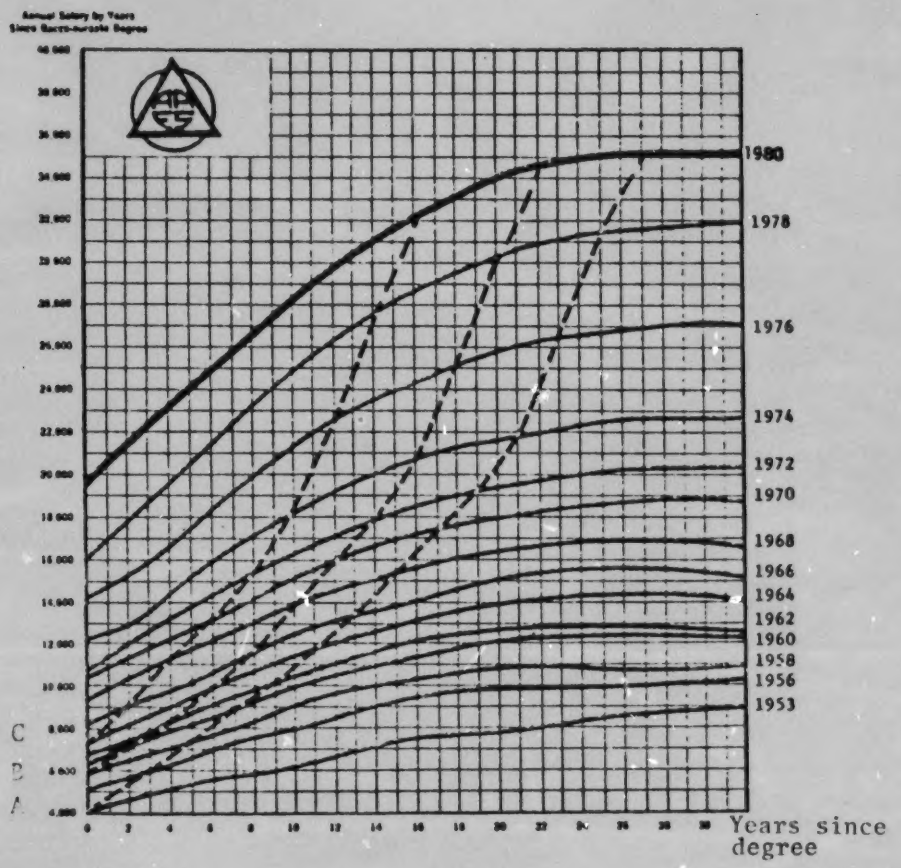
The EMC's "Placement of Engineering and Technology Graduates 1981" gives the average starting salary accepted by new baccalaureate engineers as $22,716. According to a survey conducted by the State Education Department in April 1982, the mean starting salary for recipients of engineering bachelor's degrees from New York colleges which were able to furnish such information* has risen appreciably over the past three years:

	1978-79	1979-80	1980-81
mean starting salary	$17,841	$20,060	$22,175

*Of 22 questionnaires, 16 schools were able to furnish salary information for bachelor's-degree recipients placed in engineering positions. Of these, 9 gave a mean salary accepted by graduates in 1978-79, 12 gave this figure for 1979-80, and 13 for 1980-81.

Table 1

Trends in Median Salaries* of Engineers, 1953-1980



Line A: salary rise for an engineer starting work in 1953 and earning the median salary each year, 1953-1980.

Line B: "median engineer's" salary rise, 1958-1980.

Line C: "median engineer's" salary rise, 1964-1980.

*Actual Salaries

Source: Engineering Manpower Commission (EMC), 1980 Professional Income of Engineers

Table 1 (contd.)

Trends in Actual Median Salaries of Engineers
1953-1980

Years Since B.S.	0	2	4	6	8	10	15	20	25	30
Median ($) 1980	19,600	21,450	23,300	25,150	26,950	28,600	31,882	33,983	35,066	35,233
Avg. % Increase 1978-80	11.0	10.3	9.3	8.5	8.0	7.5	6.3	5.6	5.7	5.2
Median ($) 1978	16,050	17,800	19,650	21,500	23,250	24,900	28,350	30,600	31,500	31,900
Avg. % Increase 1976-78	6.3	8.6	9.0	8.3	8.6	8.3	9.3	9.3	9.0	8.4
Median ($) 1976	14,250	15,200	16,650	18,450	19,850	21,350	23,900	25,800	26,700	27,350
Avg. % Increase 1974-76	8.6	9.4	7.4	8.4	8.0	8.7	8.6	9.7	9.3	10.4
Median ($) 1974	12,150	12,800	14,500	15,800	17,100	18,200	20,400	21,600	22,500	22,650
Avg. % Increase 1972-74	6.8	3.3	5.1	5.4	5.5	5.7	6.5	6.0	5.7	5.5
Median ($) 1972	10,700	12,000	13,150	14,250	15,400	16,350	18,050	19,300	20,200	21,400
Avg. % Increase 1970-72	1.0	3.3	3.9	4.2	4.0	3.8	3.7	4.2	4.3	4.3
Median ($) 1970	10,500	11,250	12,200	13,150	14,250	13,200	16,800	17,800	18,600	18,800
Avg. % Increase 1968-70	5.8	4.3	4.2	3.9	4.8	4.9	4.9	4.6	5.2	5.8
Median ($) 1968	9,400	10,350	11,250	12,200	13,000	13,850	15,300	16,300	16,850	16,850
Avg. % Increase 1966-68	6.3	7.5	7.7	7.0	6.0	5.4	5.6	4.2	3.8	4.5
Median ($) 1966	8,350	9,000	9,750	10,700	11,600	12,500	13,750	15,050	15,650	15,450
Avg. % Increase 1964-66	7.2	5.5	4.5	3.8	4.5	4.8	3.7	4.1	4.5	4.2
Median ($) 1964	7,300	8,100	8,950	9,950	10,650	11,400	12,800	13,900	14,350	14,250
Avg. % Increase 1962-64	4.0	4.7	3.6	5.0	4.6	4.8	3.8	4.7	5.8	6.1
Median ($) 1962	6,740	7,400	8,350	9,050	9,750	10,400	11,900	12,700	12,850	12,700
Avg. % Increase 1960-62	3.5	2.1	3.5	3.6	2.7	2.8	4.1	2.7	1.8	1.4
Median ($) 1960	6,300	7,100	7,800	8,450	9,250	9,850	11,000	12,050	12,400	12,350
Avg. % Increase 1958-60	3.8	5.0	5.7	4.9	5.4	4.1	5.0	5.8	7.7	6.7
Median ($) 1958	5,850	6,450	7,000	7,700	8,350	9,100	10,000	10,800	10,750	10,900
Avg. % Increase 1956-58	8.5	6.6	5.1	5.0	4.9	8.3	3.5	5.1	4.8	3.4
Median ($) 1956	5,000	5,700	6,350	7,000	7,600	7,800	9,350	9,800	9,800	10,200
Avg. % Increase 1953-56	7.7	8.0	8.6	8.7	10.7	8.6	8.8	8.8	5.1	6.4
Median ($) 1953	4,050	4,600	5,050	5,550	5,750	6,200	7,400	7,750	8,500	8,850
Total % Increase 1953-74	200	178	187	185	197	194	176	179	165	165

Source: Engineering Manpower Commission (EMC), 1980 Professional Income of Engineers

Table 2
Analysis of Living Cost Effect on Engineering Salaries
from Start Date to Present

Year Started as an Engineer	# Years Experience to 1980	Start Rate Current $	Start Rate *Constant $	1980 Rate Current $	1980 Rate *Constant $	Percent Increase Current $	Percent Increase *Constant $
1953	27	4,050	5,056	35,500	14,338	777	184
1958	22	5,850	6,740	34,700	14,014	493	108
1964	16	7,300	7,858	32,550	13,146	346	67
1970	10	10,500	9,028	28,650	11,571	173	28
1980	<1	19,800	7,997				

*1967 = 100%

SOURCE: EMC, 1980 Professional Income of Engineers

Table 3

Annual Percent Changes in Earnings and Compensation: 1969 to 1979

	1969-1970	1970-1971	1971-1972	1972-1973	1973-1974	1974-1975	1975-1976	1976-1977	1977-1978	1978-1979
Current dollars:										
Hourly earnings, all non-farm business workers	6.3	6.8	7.2	6.5	7.6	6.8	7.3	8.0	8.4	8.3
Hourly earnings, all workers in manufacturing	5.0	6.6	7.0	7.1	8.1	9.3	8.1	8.8	8.6	8.4
Constant (1967) dollars:										
Hourly earnings, all non-farm business workers	.4	2.2	3.9	.3	-3.0	-2.1	1.4	1.4	.7	-2.8
Hourly earnings, all workers in manufacturing	-1.0	2.1	3.7	.7	-.7	-1.6	2.0	2.3	1.0	-2.8
Consumer Price Index	5.9	4.3	3.3	6.2	11.0	9.1	5.8	6.5	7.6	11.5

Source: U.S. Bureau of Labor Statistics

Table 4

Median Annual Salaries of Starting Engineers
and
Median Earnings of All Professional and Technical Workers

	1967	1968	1969	1970	1972	1974	1976	1978	Average Annual percent change
Engineers with no experience	n.a.	9,400	n.a.	10,500	10,700	12,150	14,250	16,050	5.7
All Professional and Technical Workers	7,540	n.a.	8,684	9,412	9,984	11,856	13,312	15,288	6.6

n.a.: not available

Sources: EMC Annual Survey, Professional Income of Engineers
U.S. Bureau of Labor Statistics

Table 5

Annual Percent Increase in Average Pay
for Selected Occupations and in Consumer Prices:
5-year Periods, 1970-1979

Occupation	1970-75	1971-76	1972-77	1973-78	1974-79
Private Industry:					
Entry and development professional levels, and advanced technical levels	6.1	6.1	6.3	7.0	7.4
Engineers	6.0	6.2	6.4	7.2	7.8
Consumer Price Index for all urban consumers	6.6	6.9	7.3	8.0	7.9

Source: U.S. Bureau of Labor Statistics

The College Placement Council's survey of job offers to 1981 graduates showed engineers receiving the highest salaries among all categories: as reported in Science, the "most desired" new bachelor engineers were offered yearly salaries averaging more than $30,000; petroleum engineers, $26,650; chemical engineers, $24,350; and electrical engineers, $22,600, while computer scientists averaged $20,700, and "humanists," $14,450.[16] These offers represented increases of 6 to 12 percent over 1980 levels; as of March 1982, increases in salary offers to engineers ranged from 5.0 percent to 14.2 percent (the latter an exceptional group, the petroleum engineers). In contrast, salary offers to business majors increased 8 to 9 percent, and to physical and earth scientists, 8.1 percent[17]

Thus the salary picture for engineers nationally continues to reflect relatively high demand for their services. In New York State, this is also true; it may be noted, however, that the EMC's report on 1980 Professional Income of Engineers showed this region of the country below the average in starting salaries for engineers (Table 6). The differences among regions were not great (the average figures varied by 6.5 percent from the lowest to the highest), but the figure may perhaps have some bearing on New York's ability to retain its engineering graduates and attract recruits from out-of-state for its industries' needs -- a topic which receives further discussion later in this report.

Engineering Manpower Projections

1. National

The current trend is up in the engineering employment market. Will employer demand for engineers continue to rise, level off but remain high, or fall? Much depends upon the impact of the recession upon the longer-term health of the nation's economy.

The number of entry-level openings varies with the overall employment rate in engineering. This, in turn, has varied with economic trends, one indicator of which is the gross national product. The National Science Foundation in 1980 observed that "the engineering unemployment rate, lagged by one year, has closely paralleled shifts in economic activity" (Figure 1, page 16). Yet, according to one observer, in 1980, a year of

Table 6

Average Starting Salaries Paid to Engineers
with Recent Bachelor's Degrees, by Region
(excluding educational employers)

Region	Lower decile	Mean	Upper decile
Middle Atlantic*	17,450	19,600	21,850
New England	17,300	19,500	22,300
East North Central	17,650	19,850	22,400
West North Central	16,950	19,700	21,800
South Atlantic	17,000	19,250	21,050
South Central	17,200	20,400	24,900
Mountain	18,150	20,400	22,400
Pacific	18,050	20,500	22,900
mean	17,469	19,900	22,450

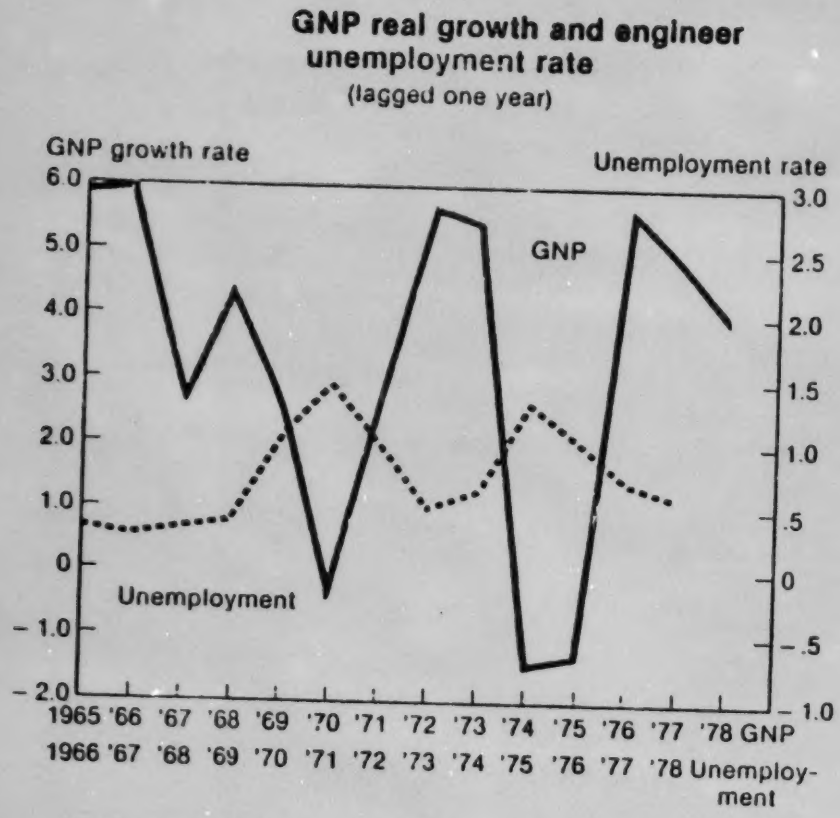
*Includes New York State, Pennsylvania and New Jersey.

Source: EMC, 1980 Professional Income of Engineers, pp. 79-87.

"zero GNP growth," demand for engineering graduates at all levels was "extremely high, and 1981 may be better."[18] The implication is that factors such as those cited in this section will keep employer demand for engineers strong, independent of GNP growth. Should GNP fall, however, demand for engineers would almost certainly soften somewhat; and there are some early indications that the current recession will continue, bringing GNP down in 1982. A New York Times spot-check in late March of economic forecasts for after-tax corporate profits in the first quarter of 1982 found predictions of declines ranging from 12 percent to 27 percent from the comparable period in 1982. Profits in the fourth quarter of 1981 had declined 7.1 percent from those in the fourth quarter of 1980, according to the U.S. Department of Commerce. That department's "flash" report or preliminary estimate of GNP for the first quarter of 1982 projected that it would decline at an annual rate of 4.5 percent in that quarter, as it had in the last quarter of 1981.[19] Economists outside the government were also predicting a slight decline in GNP for 1982.[20] The effect of such a development on demand for engineers in the economy cannot at present be foreseen.

Research and development expenditures by industry must also have an impact on employer demand, since business and industry employ around 80 percent of engineers. Business Week, surveying 744 companies in early 1981 for its annual "R & D Scoreboard," found that research and development spending, which began to grow in the late 1970's, was 16.4 percent higher in 1981 than in 1979 — 4 percent higher than the inflation rate. The largest increases were in oil service and supply (up 37.5 percent) and semiconductor companies (up 32.5 percent).[21] In their annual research and development forecast, Battelle Columbus Laboratories have predicted that total R & D expenditures in the U.S. will reach $77.6 billion in 1982, 12.4 percent higher than the $69.1 billion figure estimated by the National Science Foundation for 1981. Adjusted by Battelle for expected inflation of 8.7 percent in 1982, such an increase would amount to 3.7 percent. Industry is expected to provide nearly 49 percent of the projected funding and to perform nearly 70 percent of the R & D work; Battelle expects government to provide 48 percent of the funding and 13 percent of the actual R & D.[22] Again, this forecast, published at the beginning of 1982, might not correctly foresee the extent or duration of the economic downturn.

Figure 1



SOURCES: Economic Report of the President, 1979 and Department of Labor, unpublished, appendix table B-12

Source: NSF 80-316, Science and Engineering Personnel, p. 6.

The high Federal priority currently given to defense makes the prospects in defense-related industry an exception to the general economic picture -- although vulnerable to a change of administration or policy. Federal R & D spending for national defense is expected to rise by 21 percent in 1982.[23] This priority was already increasing the hiring of engineers in defense-related industries in early 1982.[24] In testimony to the Science and Technology Committee of the U.S. House of Representatives in the fall of 1981, General Robert T. Marsh, head of the U.S. Air Force Systems Command, stated that the military would increase its demand for engineers in the near future; according to General Marsh, the Air Force was already short of its minimum needs by 1,100 engineers.[25]

Demand projections for engineers vary by field. The American Institute of Chemical Engineers recently found that demand for chemical engineers at the bachelor's and master's levels grew at about the same rate as supply from 1975 to 1980; the Institute forecast that this trend would continue through 1986.[26] In the present job market, a Fox-Morris survey of 3,200 employers at the end of 1981 showed greatest demand for experienced engineers in the electrical, electronics, and mechanical fields; for recent graduates, the fields most sought were electrical, mechanical, and chemical engineering.[27] The National Science Foundation reported in 1981 that, although the total number of scientists, engineers, and technicians employed in private industry remained at approximately 2.1 million from 1970 to 1980, there was a significant trend to employment of scientists and engineers in nonmanufacturing industries. In 1980, nonmanufacturing industries accounted for 41 percent of industry's total employment for these professions, and for 60 percent of employment growth between 1978 and 1980. According to the NSF, nonmanufacturing activity is projected to grow faster than manufacturing activity through the 1980's; this might lead to an increased demand for civil engineers, and perhaps to less of an increase in demand for electrical/electronics and mechanical engineers (the largest specialties among engineers employed in manufacturing industry).[28]

The retirement rate from the profession is another factor which must be taken into account in attempts to project manpower needs. The National Science Foundation has published counts of scientists and engineers by field and age; its figures for 1978 (the most recent available) show that, for all engineering fields taken together, the number retiring between 1984 and 1988 (assuming a retirement age of 65) will be almost 62 percent greater than the number retiring between 1979 and 1982 (Table 7).[29] Table 8, based on NSF data, shows the breakdown by fields. The retirement rate is highest for the very fields in which demand is likely to remain high, according to the projections just cited -- civil, electrical/electronics, and mechanical engineering. It should be noted that the NSF figures represent surveys sampling representative groups of engineers in the population, not just those who are employed. Most engineers aged 50 to 64, however, were probably included in the NSF's "Experienced Sample of Scientists and Engineers," which was "drawn from those . . . in the employed labor force at the time of the 1970 decennial census" (NSF 80-304, U.S. Scientists and Engineers 1978, p. ii). The figures given above cannot, of course, be taken as exact; but they do serve to indicate trends. It would appear that a greater number of job vacancies in most engineering fields will be created by retirement in the coming decade than in the preceding one -- half again as many, at a conservative estimate.

2. New York State

Over the last decade, New York's industrial mix has been changing. According to figures compiled by the New York Departments of Labor and Commerce, the State has lost jobs in manufacturing -- about 353,000 since 1970. During the same period, the other parts of the private sector gained 396,000 -- enough jobs to account for a net gain of 43,000. Looked at more closely, New York's loss in manufacturing industry leveled off between 1976 and the end of 1981, for 340,000 of the job losses occurred between 1970 and 1975. The Labor Department actually recorded a net gain of 10,000 jobs in manufacturing between

Table 7

Engineers in 1978: Percentages by Age in Selected Fields

Field	Total Number	Percent in each Age Group										
		24 and under	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70 and over
Engineers-all fields:	1,396,400	4.8	14.0	13.3	12.3	11.7	11.5	12.1	8.9	5.5	3.4	2.4
Aeronautics/astro:	48,700	2.5	17.2	11.5	11.7	12.5	12.9	12.7	11.3	5.1	1.2	1.2
Chemical:	67,900	8.7	18.3	14.4	11.9	9.9	8.1	9.6	10.0	6.3	2.1	1.0
Civil:	183,500	4.5	15.5	11.4	12.9	11.7	11.4	12.4	7.3	5.3	3.9	3.7
Electrical/electron:	243,000	5.9	15.5	15.0	13.5	13.3	12.4	10.5	6.9	3.8	1.8	1.4
Mechanical:	233,700	5.2	13.3	14.1	12.2	11.6	11.4	13.4	10.1	5.2	2.4	1.2
Other:	619,500	4.1	12.6	12.9	11.8	11.3	11.4	12.5	9.5	6.4	4.5	3.0

Source: NSF 80-304, U.S. Scientists and Engineers 1978: Detailed Statistical Tables.

Table 8

Engineers Retiring 1979-83, 1984-88, and 1989-93:
Breakdown by Field

Field	No. retiring 1979-83	No. retiring 1984-88	No. retiring 1989-93	Percent change, 1979-83 to 1984-88	Percent change, 1979-83 to 1989-93
All engineers	77,300	124,900	169,300	+62	+119
Aero./Astro.	2,500	5,500	6,200	+120	+148
Chemical	4,300	6,800	6,500	+58	+51
Civil	9,800	13,400	22,800	+37	+133
Elec./Electron	9,200	16,800	25,500	+83	+177
Mechanical	12,100	23,500	31,200	+94	+158
Other	39,400	58,900	77,200	+49	+96

Source: NSF 80-304, U.S. Scientists and Engineers 1978: Detailed Statistical Tables.

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1976 and the end of 1981. The recession, however, brought further job losses of 23,000 in the first two months of 1982. At present, according to the State Labor Department, approximately 19 percent of jobs in New York State are in manufacturing, and the proportion is declining; some 40 percent of jobs are in the service and finance sectors -- a rising figure.

In the manufacturing sector, perhaps a little over half of remaining employment (i.e., about 10 percent of all jobs in the State) is in "high technology" industry, an often used but "nebulous term that roughly includes those technical and scientific fields in which advances are occurring rapidly – such as computers and telecommunications, genetic engineering and the design of new materials."[30] Battelle Laboratories of Columbus, Ohio, have been commissioned by the New York State Science and Technology Foundation to study the State's economy and recommend types of industry which show the greatest promise for its future development. In a preliminary report issued in January 1981, Battelle recommended "a focused growth program targeting upon the attraction and retention of high technology industries, new technology industries, and related research and development functions" for New York, building on the State's existing strengths in these areas.[31] The employment of electrical and electronics engineers in New York bears out this picture of relative strength in "high-technology" industries. According to the State Department of Labor, electrical engineers are the largest single group employed in the "Engineers, Technical" category, accounting for almost 28 percent of all engineering employment in its projections for 1982 (Table 9). The Labor Department has issued occupational employment projections through 1985. The most recent such publication, issued in 1981, estimates job openings resulting from economic growth, separations from the labor force, and geographic and occupational transfer. For the period 1974-1985, the Labor Department projects an average of 8,965 job openings in engineering each year in New York State. Table 32 (page 66) shows the regional breakdown. Approximately 29 percent (2,554) of engineering job openings in the State are projected to be in electrical engineering (Table 9).

TABLE 9. EMPLOYMENT (A) AND JOB OPENINGS, BY OCCUPATION,
NEW YORK STATE (REGION 14) 1974-1985

OCCUPATION	EMPLOYMENT			AVERAGE ANNUAL OPENINGS 1974-1985				
	1974	FY 1982 (B)	1985	TOTAL	GROWTH	SEPARATIONS	GEOGRAPHIC TRANSFERS	OCCUP TRANS.
TOTAL, ALL OCCUPATIONS	7,447,728	7,706,817	7,815,227	764,944	33,409	300,987	84,447	346,101
PROFESSIONAL, TECHNICAL, KINDRED	1,255,783	1,331,828	1,363,648	133,534	9,806	47,732	24,134	51,862
ENGINEERS, TECHNICAL	98,064	102,455	104,294	8,965	566	1,702	2,521	4,176
ENGINEERS, CIVIL	14,735	15,923	16,420	1,258	153	357	223	525
ENGINEERS, ELECTRICAL	26,502	28,549	29,406	2,554	264	349	856	1,085
ENGINEERS, INDUSTRIAL	16,568	16,696	16,750	1,186	17	284	367	518
ENGINEERS, MECHANICAL	13,948	14,848	15,225	1,239	116	247	282	594
ENGINEERS, OTHER	26,311	26,439	26,493	2,729	17	465	793	1,454

(A) Defined as number of persons (not jobs) by place of work. Total employment was derived by adjusting nonagricultural employment, using national ratios, to eliminate multiple jobholding, and adding persons with a job, but not on employer payrolls. Estimates were made of self-employed and unpaid family workers, domestics, and agricultural workers.

(B) Figures for 1982 are simple linear interpolations of 1974 and 1985 figures.

Source: New York State Department of Labor, Projected Annual Job Openings, New York State 1974-1985, 1981.

The discussion which follows will compare the current and projected supply of engineers with the projected demand. Before doing so, however, we need to discuss the basis of these and other projections of employer demand, in order to judge the extent of their usefulness.

The State Department of Labor made its original employment projections in 1974 for the period 1974-1985. On the basis of actual employment figures for 1974, and taking into account such factors as projected population change, the Labor Department projected 1985 levels of employment by occupation for New York's thirteen Vocational Education Planning Regions and for the State as a whole. (Table 10 lists the Vocational Education Planning Regions.) Linear interpolation yielded employment projections for 1982. Total job openings due to growth were estimated by subtracting the 1974 employment from the 1982 and 1985 figures; to these were added estimates of openings due to permanent separations from the labor force (such as death and retirement). In 1980, Labor Department economists devised a means to estimate job openings due to geographic transfers (out-of-State) and occupational transfers (out of a given occupational category and into a different one), using the One Percent Public Use Sample from the 1970 U.S. Census, which provided occupational and geographic outmobility rates for the State from 1965 to 1970. Since no comparable questions were asked in the 1980 census, however, these 1965-to-1970 mobility rates were applied to updated population figures from yearly U.S. Current Population Surveys in order to revise the projections of job openings. These are the best projections currently available for New York State; since they are based on 1974 employment figures and 1965-1970 mobility rates, however, they cannot be regarded as highly accurate. The employment projection for 1982, for example, is almost certainly too high. A Labor Department count in 1981 gave the total employment for that year as 7,404,000, whereas the 1974 projection had put the number for 1982 at 7,706,000 (Table 9) -- 4.1 percent more, an unlikely rise in the light of the relatively steady 1974-1981 level. For regions within the State, and for individual occupations, the rate of error may be higher, similar, or lower. Assuming a 5

Table 10

New York State
Vocational Education Planning Regions

Region	Counties
Region 1, Nassau-Suffolk:	Nassau, Suffolk
Region 2, New York City:	Bronx, Brooklyn, New York, Queens, and Richmond
Region 3, Mid-Hudson:	Dutchess*, Orange, Putnam, Rockland*, Sullivan, Ulster, and Westchester*
Region 4, Upper Hudson:	Albany*, Columbia, Fulton, Greene, Montgomery*, Rensselaer*, Schenectady*, Schoharie and Saratoga*
Region 5, Lake Champlain-Lake George:	Clinton, Essex, Franklin, Hamilton, Warren and Washington
Region 6, Black River-St. Lawrence:	Jefferson, Lewis, and St. Lawrence
Region 7, Upper Mohawk Valley:	Herkimer*, Madison*, and Oneida*
Region 8, Southern Tier East:	Broome*, Chenango, Delaware, Otsego, and Tioga*
Region 9, Central:	Cayuga, Cortland, Onondaga*, Oswego*, and Tompkins
Region 10, Genesee-Finger Lakes:	Genesee, Livingston*, Monroe*, Ontario*, Seneca, Wayne*, Wyoming and Yates
Region 11, Southern Tier Central:	Chemung*, Schuyler, and Steuben
Region 12, Western:	Erie*, Niagara*, and Orleans*
Region 13, Southern Tier West:	Allegany, Cattaraugus, and Chautauqua

*Part of a major labor market area.

Source: New York State Department of Labor

percent margin of error in either direction for each category of job openings (those due to growth, separations from the labor force, geographic transfers, and occupational transfers), the average number of job openings for engineers annually between 1974 and 1985 could be 8,500 to 9,400; the slower rate of growth indicated by the 1981 employment figure could reduce this estimate, although employment for engineers might be expected to grow at a somewhat higher rate than the average.

When we try to look at the regions of the State separately, we are on still more uncertain ground. The Labor Department projections, as we have seen, must be regarded as only approximate. Such a number as 1,823, the average number of annual job openings for engineers in the Long Island region, or 206, the number of openings in industrial engineering in that region, may well understate the case, since population and employment have both been increasing there. Figures given by the Labor Department for other regions may be inaccurate in either direction. Those assembled by other organizations by means of employer surveys must be regarded with still less confidence. In 1981, an organization with representatives from business, industry, government,and education was formed on Long Island to assess the needs of employers there for technical manpower. The Regional Industrial-Technical Education Council (RI-TEC) conducted a survey of employers in the fall of 1981. Based on responses by 71 of the 200 companies surveyed (35.5 percent), RI-TEC published figures projecting a need for an additional 8,000 engineers on Long Island (including 2,000 electrical/electronics engineers) over the next five years.[32] However, such results need to be interpreted with caution. There is no means of determining how realistic companies may have been in estimating their manpower needs. The terms used in the RI-TEC survey ("engineer," "technician," and the like) are very broad ones. For reasons such as these, it is impossible to cite the RI-TEC figures as indicative of the demand for engineers in the region.

The only other regional study by a non-governmental agency was conducted in the Binghamton area by the National Center for Higher Education Management Systems

(NCHEMS) of Boulder, Colorado, for the State University of New York. The NCHEMS May 1981 survey showed that high-technology industry accounted for "a significant part of employment and economic growth in the Binghamton area."[33] NCHEMS reported that, of 33,000 people employed in the area's high-technology companies, more than 3,100 had engineering degrees. The ten major employers recruit nationally for about 270 engineering positions annually, filling "a substantial number" with graduates of colleges in the Northeast (New York, New England, Pennsylvania, and New Jersey).[34] Projections for future hiring were not given.

Thus, accurate projections of the demand for engineers in the New York economy are difficult to obtain. For the individual regions of the State, this is even more the case. However, engineers have relatively high mobility, particularly in periods of high demand. As we shall see, New York's engineering graduates and companies hiring engineers participate in a national market.

Engineering Manpower Supply

Comparison of Engineering Supply and Demand Projections, U.S.

Before New York State's engineering degrees and enrollments are examined in greater detail, it will be useful to sum up what has been said about supply and demand projections nationally in this field.

The most complete survey of engineering manpower studies and projections is the second edition of Supply and Demand for Scientists and Engineers by Betty M. Vetter of the Scientific Manpower Commission (January 1982). After summarizing projections by the U.S. Bureau of Labor Statistics, the National Science Foundation and the U.S. Department of Education, the engineering societies, and the Engineering Manpower Commission, Vetter concludes that most of these projections indicate that the supply of graduates in "most of the science and engineering areas" can be expected to fill available job openings resulting from growth and replacement of those leaving the work force. In engineering, however, Vetter notes a serious shortage in the supply of Ph.D. recipients and observes that experts disagree as to whether the supply of all engineers will exceed the demand, or whether there will be shortages in at least some fields.[35]

In August 1981, the U.S. Bureau of Labor Statistics (BLS) published projections of occupational employment growth through 1990, using three different scenarios for economic growth. In the "low-trend" scenario, BLS assumed "a decline in the rate of labor force expansion, continued high inflation, and modest increases in production and productivity."[36] Two "high-trend" scenarios were posited, both based on large increases in GNP: "High Trend I," which assumed greater growth in the labor force, and "High Trend II," which assumed greater productivity. Table 11 shows the BLS projections of growth in engineering employment according to these three scenarios. From these projections the following picture emerges:

Change in Engineering Employment, 1978-1990

	Low Trend	High Trend I	High Trend II
Total Change	433,000	553,000	460,000
Average annual openings due to economic growth	36,083	46,083	38,333

A report issued by the State University of New York, "Investment Needs: Engineering and the Engineering Technologies," cites these figures, plus estimates of openings due to death, retirements, and occupational out-transfers made by William R. Upthegrove in 1980, to obtain the following figures for average annual job openings in engineering nationwide through 1990:[37]

Total Annual Job Openings in Engineering, 1978-1990

Low Trend	High Trend I	High Trend II
104,083	114,083	106,333

The Bureau of Labor Statistics assumes that 70 percent of engineering positions are filled by recent graduates, giving the following numbers of positions to be filled by new degree holders at all levels yearly to 1990:

Table 11

U.S. Engineering Employment
Actual 1978 and Projected 1990

	Employment (in thousands)				Percent change, 1978-90		
	1978	1990 Low-trend	1990 High-trend I	1990 High-trend II	Low-trend	High-trend I	High-trend II
Engineers	1,071	1,504	1,624	1,531	40.41	51.61	42.92
Aero-astronautic engineers	57	98	104	100	70.35	80.86	74.81
Chemical engineers	53	68	73	70	28.92	37.70	31.80
Civil engineers	149	208	218	211	39.38	45.59	40.97
Electrical engineers	291	441	479	448	51.18	64.41	53.90
Industrial engineers	109	146	159	148	34.03	46.49	36.37
Mechanical engineers	199	274	300	279	37.56	50.67	40.18

Source: Max L. Carey, "Occupational Employment Growth through 1990," Monthly Labor Review (August 1981), p. 49.

Low Trend	High Trend I	High Trend II
72,858	79,858	74,433

Table 12 shows the EMC's count of engineering and Bachelor of Technology degrees, 1978-1981, along with Scientific Manpower Commission projections through 1989, and the average annual number of degrees granted in each category, 1978-1989.[38] Omitting Bachelor of Technology degrees for the moment, the average total number of engineering degrees annually is 85,226. According to the EMC study, "Placement of Engineering and Technology Graduates 1980," approximately 78 percent of bachelor's degree recipients, 63 percent of master's recipients, and 83 percent of doctorates in engineering were newly employed as of December 1980.[39] Assuming that 20 percent of the doctorates went into teaching, 63 percent of them were available to fill positions outside academia (see Table on page 106). Applying these percentages to the numbers of degree recipients counted by the EMC in 1980, approximately 57,784, or about 73 percent of the 78,736 degree holders, were newly employed. Assuming further that all of them took engineering jobs, applying this percentage to the annual average of 85,226 degrees yields 62,215 graduates annually available to fill non-teaching engineering positions in the U.S.

This figure should be augmented by a certain number of Bachelor of Technology (B. Tech.) holders, for schools responding to this question on the State Education Department survey indicated that roughly 70 percent accepted positions in which their job title was "Engineer" or "Associate Engineer." Applying this percentage to the estimated average of 10,873 B. Tech. degrees awarded annually between 1978 and 1990, we posit that 7,611 B. Tech. recipients will fill engineering positions. Thus, the total number of new graduates available to fill engineering positions each year may be estimated at 69,826. This figure is somewhat below the BLS projections of average annual positions to be filled by new graduates:

	Low Trend	High Trend I	High Trend II
Positions	72,858	79,858	74,433
New Graduates	69,826	69,826	69,826
Difference	3,032	10,032	4,607

Table 12

U.S. Engineering Degrees
1978-1981 and Projected to 1989-1990

Year	Bachelor's Degrees in Engineering	Bachelor of Technology Degrees	Master's Degrees in Engineering	Doctorates in Engineering	Total
1978	46,095	9,366	16,812	2,573	74,846
1979	52,598	8,714	15,624	2,815	79,751
1980	58,742	10,048	17,243	2,751	88,784
1981	62,935	11,657	17,914	2,841	95,347
1982*	65,373	10,550	16,340	2,330	94,593
1983*	69,581	10,910	16,440	2,270	99,201
1984*	75,999	11,160	16,310	2,230	105,699
1985*	75,782	11,330	16,310	2,170	105,592
1986*	74,243	11,480	16,200	2,130	104,053
1987*	72,566	11,560	16,200	2,090	102,416
1988*	71,789	11,730	16,060	2,050	101,629
1989*	71,372	11,970	15,930	2,000	101,272
1990*					
	797,075	130,475	197,383	28,250	
	avg. 66,423	avg. 10,873	avg. 16,449	avg. 2,354	

*Projected (SMC projections for engineering baccalaureates, NCES for all other degrees)

Source: Betty M. Vetter, "Supply and Demand for Scientists and Engineers," (Washington, D.C.: Scientific Manpower Commission, January 1982), pp. 13-14.

This may be a "best estimate" of the match between demand and supply, but obviously it depends upon many assumptions about the economy, the market for recent degree holders and experienced engineers, the percentages of degree holders accepting engineering employment, and the like. Given the approximate nature of the "best estimate" and the non-High Trend performance of the U.S. economy so far in the 1980's, Vetter's statement that the supply will probably approximately match the demand seems reasonable. If recent levels of demand hold up, it appears that there will be at most a modest shortage of engineers in the nation throughout the 1980's. Since much of New York's remaining industrial employment is in "high technology" industries, this modest shortage may be assumed to extend to New York State.

Degrees Granted: New York State*

1. New York in the National Context

In 1981, 286 postsecondary institutions in the U.S. had at least one professionally accredited degree program in engineering (bachelor's and above).[40] Twenty are in New York State (Tables 13, 14, 15, Figure 2). In addition, the State has 6 institutions which offer one or more programs leading to the Bachelor of Technology or B.S. in engineering technology degree (Table 16, Figure 3), and 52 institutions which offer one or more programs leading to an associate degree in engineering science or in mechanical and engineering technologies (Table 17, Figure 4). In 1979-1980, the most recent year for which Department data are available, these New York institutions granted 4,666 associate degrees in mechanical and engineering technologies, 613 Bachelor of Technology degrees, 4,990 baccalaureates in engineering, 1,673 master's and 235 doctoral degrees -- a total of 12,177. Figures 5 and 6, and Table 18, show numbers of degrees conferred in the State in engineering and engineering technologies, 1960-1980; Figures 7 and 8 show engineering degrees as a percentage of all New York degrees, 1960-1979.

*The term "engineering" refers in this report to programs which lead to the Bachelor of Science (B.S.) degree in engineering or to the Bachelor of Engineering (B.E.) degree. Unless otherwise stated, Bachelor of Technology (B. Tech.) degrees or B.S. degrees in technology are not included.

Table 13

NYS Postsecondary Institutions Offering
Bachelor's-Degree Programs in Engineering
(HEGIS 0901-0924 and 0999)

Institution	Regents Ed. Region		County
SUNY at Buffalo	1	Western	Erie
SUNY at Stony Brook	8	Long Island	Suffolk
SUNY Maritime College	7	New York City	Bronx
NYS Col. of Ceramics at Alfred University	1	Western	Allegany
°NYS Col. of Agriculture & Life Sciences at Cornell U.	3	Central	Tompkins
NYS Col. of Environmental Science & Forestry	3	Central	Onondaga
*CUNY-The City College	7	New York City	New York
°CUNY-The College of Staten Island	7	New York City	Richmond
Clarkson Col. of Technology	4	Northern	St. Lawrence
Columbia University	7	New York City	New York
The Cooper Union for the Advancement of Science and Art	7	New York City	New York
Cornell University	3	Central	Tompkins
Hofstra University	8	Long Island	Nassau
Manhattan College	7	New York City	Bronx
Polytechnic Institute of NY-Main Campus	7	New York City	Kings
Long Island Center	8	Long Island	Nassau
Pratt Institute	7	New York City	Kings
Rensselaer Polytechnic Institute	5	Northeast	Rensselaer
*Rochester Institute of Tech.	2	Genesee Valley	Monroe

Institution	Regents Ed. Region	County
Syracuse University	3 Central	Onondaga
Union College	5 Northeast	Schenectady
University of Rochester	2 Genesee Valley	Monroe
Webb Institute of Naval Architecture	8 Long Island	Nassau

°Programs not registered for professional (licensure) purposes by NYSED.
*Also offers a curriculum in HEGIS 0925.

Table 14

NYS Postsecondary Institutions Offering
the Master's Degree in Engineering

Institution	Regents Ed. Region		County
*SUNY at Buffalo	1	Western	Erie
*SUNY at Stony Brook	8	Long Island	Suffolk
*NYS College of Agriculture & Life Sciences at Cornell	3	Central	Tompkins
*NYS College of Ceramics at Alfred University	1	Western	Allegany
*NYS College of Environmental Science & Forestry	3	Central	Onondaga
CUNY-The City College	7	New York City	New York
*Clarkson College of Technology	4	Northern	St. Lawrence
*Columbia University	7	New York City	New York
The Cooper Union for the Advancement of Science and Art	7	New York City	New York
*Cornell University	3	Central	Tompkins
Manhattan College	7	New York City	Bronx
Polytechnic Institute of New York			
*Main Campus	7	New York City	Kings
*Long Island Center	8	Long Island	Nassau
Westchester Campus	6	Mid-Hudson	Westchester
*Rensselaer Polytechnic Institute	5	Northeast	Rensselaer
Rochester Institute of Technology	2	Genesee Valley	Monroe
*Syracuse University - Main Campus	3	Central	Onondaga
Mid-Hudson Graduate Center	6	Mid-Hudson	Dutchess
Endicott-Owego Graduate Center	3	Central	Broome
Griffiss Air Force Base Grad. Ctr.	5	Northeast	Oneida
Corning Graduate Center	2	Genesee Valley	Steuben

Institution	Regents Ed. Region	County
*Union College	5 Northeast	Schenectady
*University of Rochester	2 Genesee Valley	Monroe

*Also offers the Ph.D., Eng.Sc.D., or D.Eng.

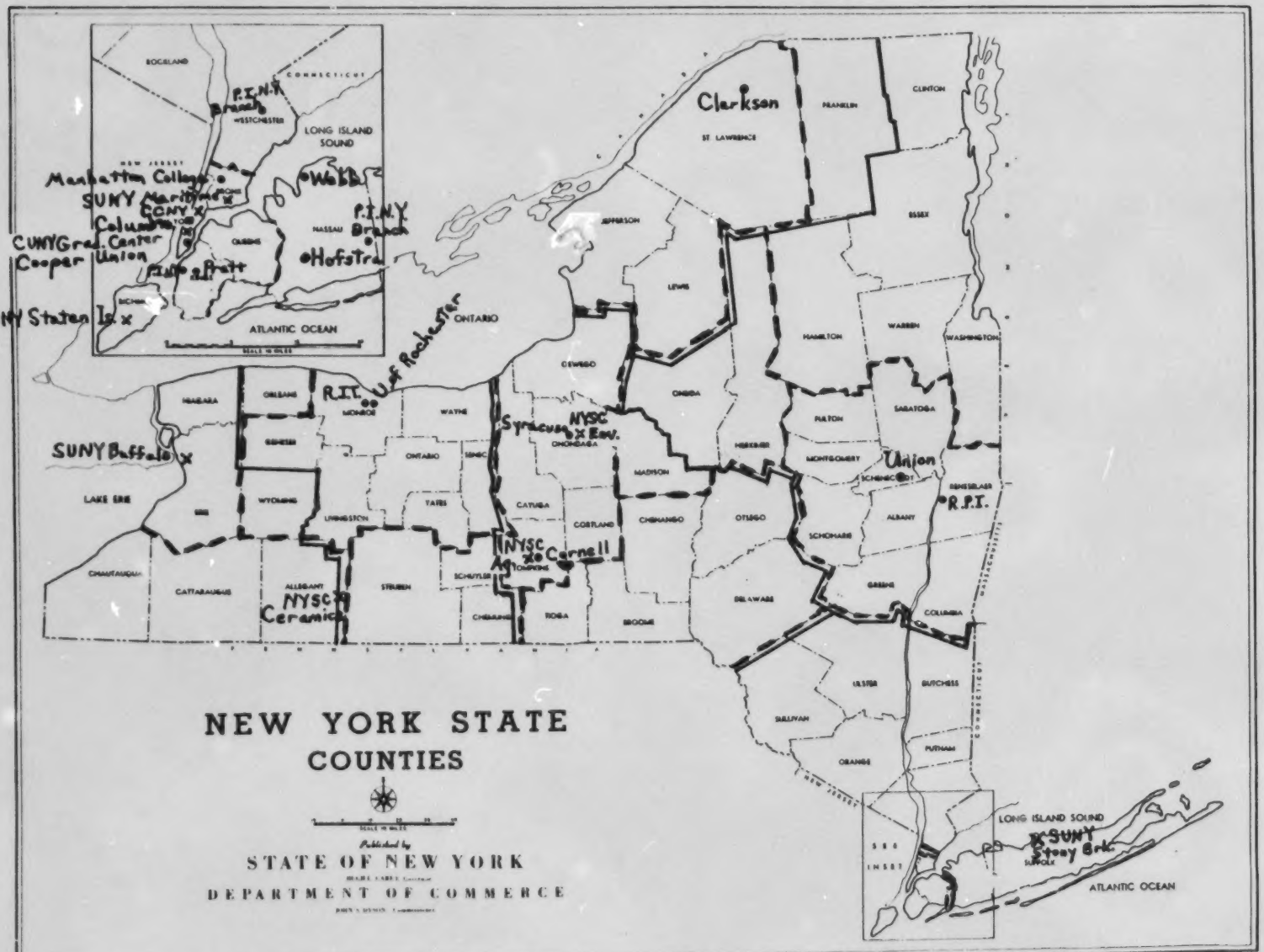
Source: NYSED, Bureau of Postsecondary Planning, 1982

Table 15

NYS Institutions Offering the Ph.D. in Engineering,
but Not the Master's Degree:

Institution	Regents Ed. Region	County
CUNY: The Graduate School and University Center	7 New York City	New York

NYS Postsecondary Institutions Offering Degrees in Engineering



X Public

● Independent

— — — — — delineates Vocational Education Planning Regions

——————— delineates Regents Postsecondary Education Regions

Figure 2

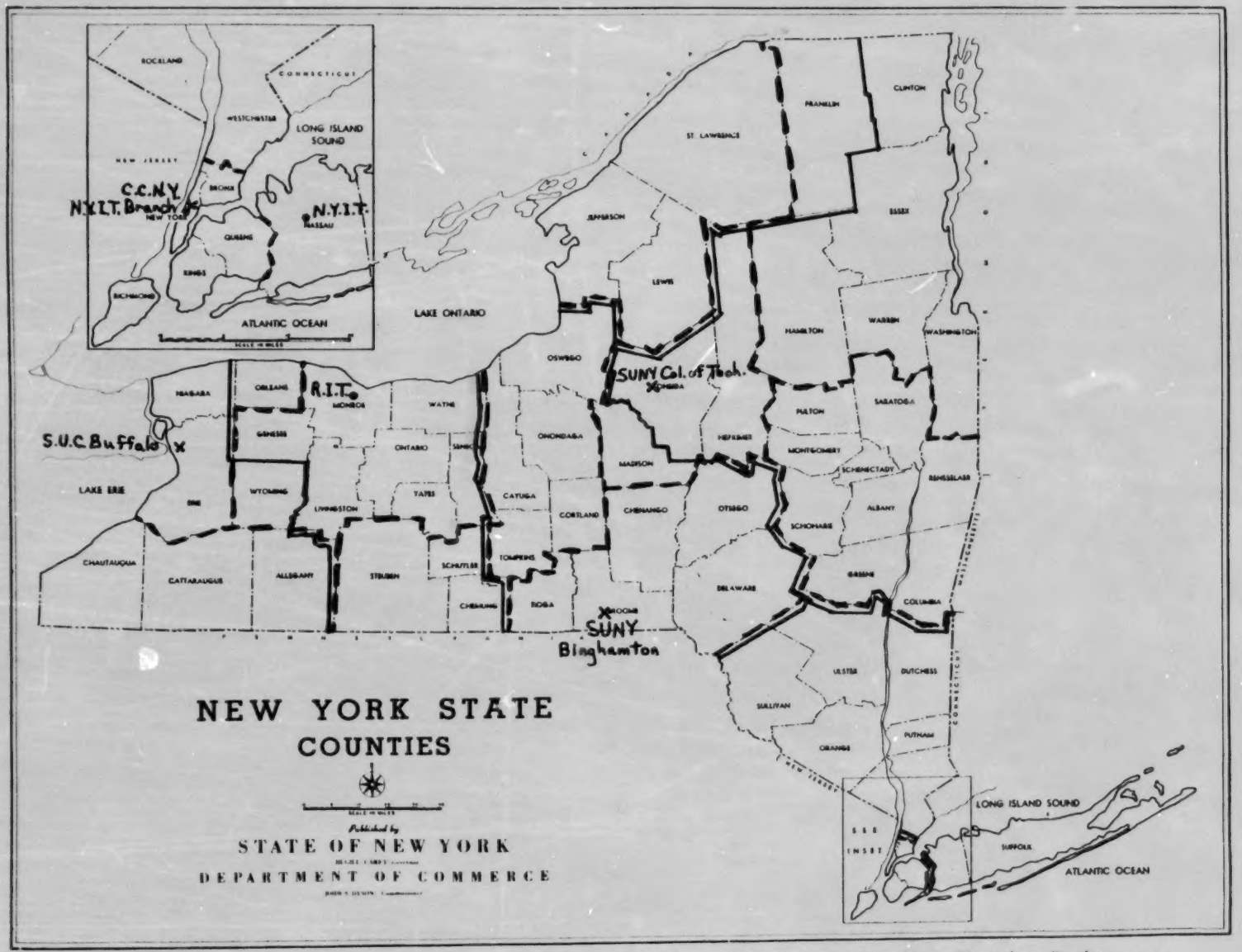
Table 16

NYS Postsecondary Institutions Offering
Bachelor's Level Programs in Engineering Technology
(HEGIS 0925)

Institution	Regents Ed. Region	County
SUNY at Binghamton	3 Central	Broome
SUC at Buffalo	1 Western	Erie
SUNY College of Technology at Utica/Rome	5 Northeast	Oneida
CUNY: The City College	7 New York City	New York
New York Institute of Technology Old Westbury Campus	8 Long Island	Nassau
Metropolitan Center	7 New York City	New York
Rochester Institute of Technology	2 Genesee Valley	Monroe

None of these programs is registered for professional (licensure) purposes by the NYS Department of Education.

NYS Postsecondary Institutions Offering Bachelor of Technology/B.S. in Engineering Technology Degrees



× Public

• Independent

— — — — — delineates Vocational Education Planning Regions

——————— delineates Regents Postsecondary Education Regions

Figure 3

53

Table 17

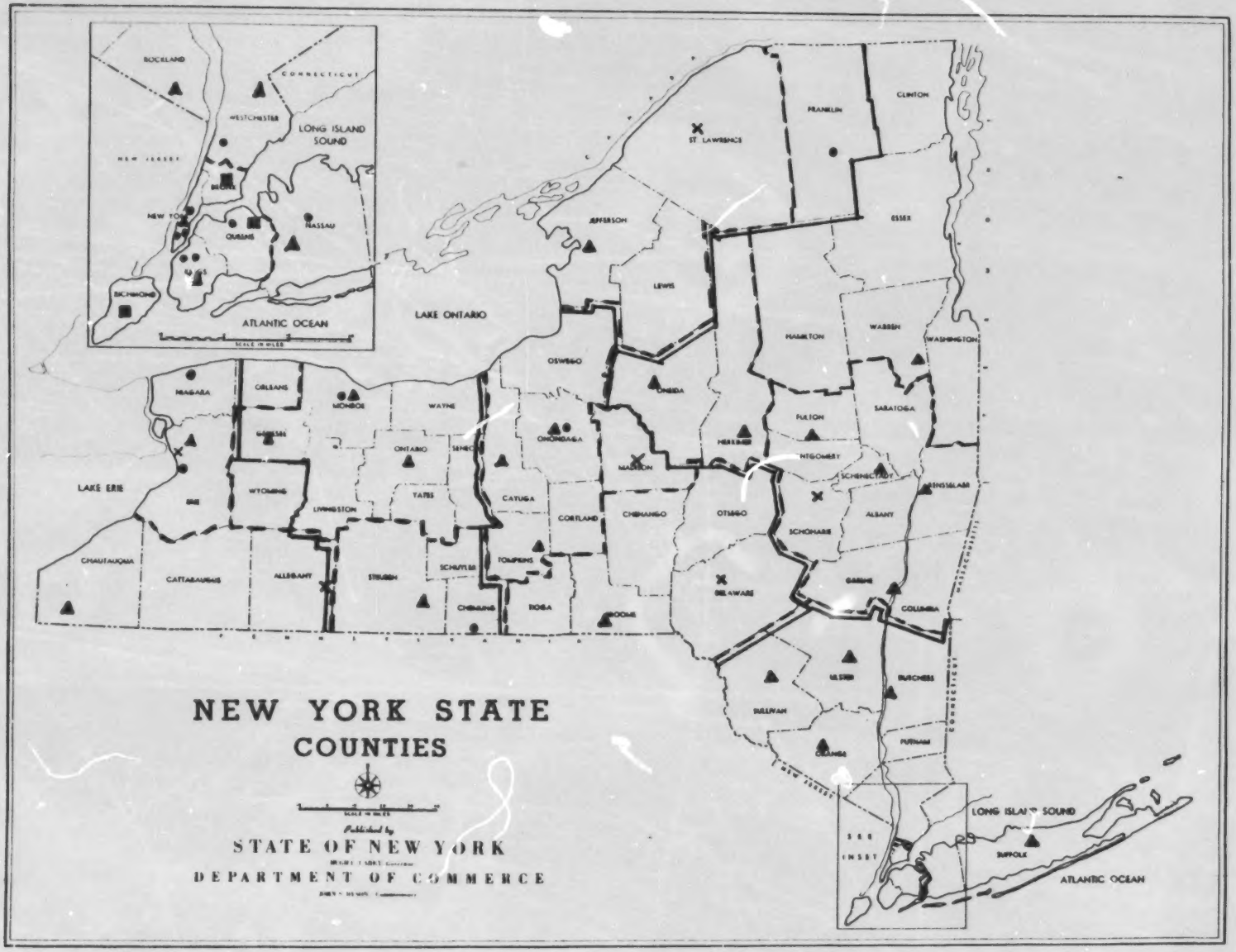
NYS Postsecondary Institutions Offering
2-year and Associate-Degree Programs
in Engineering/Technology (A.S., A.A.S., A.O.S.)
HEGIS 5301-5317, 5399, 5609

Institution	Regents Ed. Region	County
SUNY at Buffalo	1 Western	Erie
SUNY A&T Colleges:		
at Alfred	1 Western	Allegany
at Canton	4 Northern	St. Lawrence
at Cobleskill	5 Northeast	Schoharie
at Delhi	3 Central	Delaware
at Farmingdale	8 Long Island	Nassau
at Morrisville	3 Central	Madison
SUNY Community Colleges:		
Adirondack Community College	5 Northeast	Warren
Broome Community College	3 Central	Broome
Cayuga County Community College	3 Central	Cayuga
Columbia-Greene Community College	5 Northeast	Greene
Community College of the Finger Lakes	2 Genesee Valley	Ontario
Corning Community College	2 Genesee Valley	Steuben
Dutchess Community College	6 Mid-Hudson	Dutchess
Erie Community College	1 Western	Erie
Fashion Institute of Technology	7 New York City	New York
Fulton-Montgomery Community College	5 Northeast	Fulton
Genesee Community College	2 Genesee Valley	Genesee
Herkimer County Community College	5 Northeast	Herkimer
Hudson Valley Community College	5 Northeast	Rensselaer
Jamestown Community College	1 Western	Chautauqua

Institution	Regents Ed. Region		County
Jefferson Community College	4	Northern	Jefferson
Mohawk Valley Community College	5	Northeast	Oneida
Monroe Community College	2	Genesee Valley	Monroe
Nassau Community College	8	Long Island	Nassau
Niagara County Community College	1	Western	Niagara
Onondaga Community College	3	Central	Onondaga
Orange County Community College	6	Mid-Hudson	Orange
Rockland Community College	6	Mid-Hudson	Rockland
Schenectady County Comm. College	5	Northeast	Schenectady
Suffolk County Community College	8	Long Island	Suffolk
Sullivan County Community College	6	Mid-Hudson	Sullivan
Tompkins-Cortland Comm. College	3	Central	Tompkins
Ulster County Community College	6	Mid-Hudson	Ulster
Westchester Community College	6	Mid-Hudson	Westchester
CUNY Senior Colleges:			
The College of Staten Island	7	New York City	Richmond
New York City Technical College	7	New York City	Kings
CUNY Community Colleges:			
Bronx Community College	7	New York City	Bronx
Queensborough Community College	7	New York City	Queens
Academy of Aeronautics	7	New York City	Queens
Bramson ORT Technical Institute	7	New York City	New York
Elizabeth Seton College	6	Mid-Hudson	Westchester
Elmira College	2	Genesee Valley	Chemung
Hilbert College	1	Western	Erie
Institute of Design & Construction	7	New York City	Kings
New York Institute of Technology			
Main Campus-Old Westbury	8	Long Island	Nassau
Metropolitan Center	7	New York City	New York

Institution	Regents Ed. Region	County
Niagara University	1 Western	Niagara
Paul Smith's College of Arts & Sciences	4 Northern	Franklin
Pratt Institute	7 New York City	Kings
Rochester Institute of Technology	2 Genesee Valley	Monroe
Syracuse University	3 Central	Onondaga
Proprietary Institution:		
Technical Career Institutes	7 New York City	New York

NYS Postsecondary Institutions Offering Associate Degrees
in Engineering Science and Mechanical and Engineering Technologies



▲ SUNY Community College
X SUNY Other
● CUNY Campuses
● Independent

– – – – – delineates Vocational Education Planning Regions

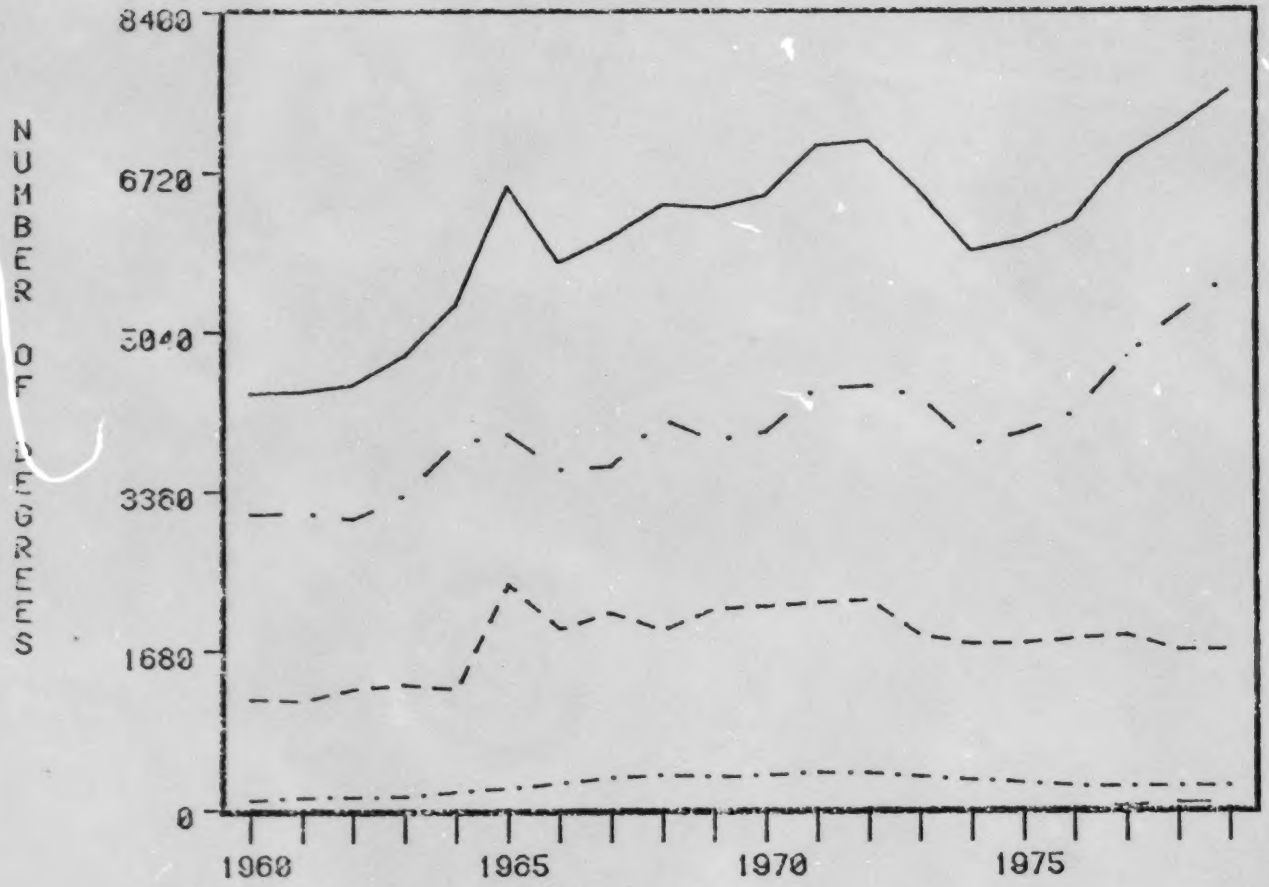
——— delineates Regents Postsecondary Education Regions

Figure 4

FIGURE 5

DEGREES IN ENGINEERING* BY LEVEL

NEW YORK STATE 1960-1980



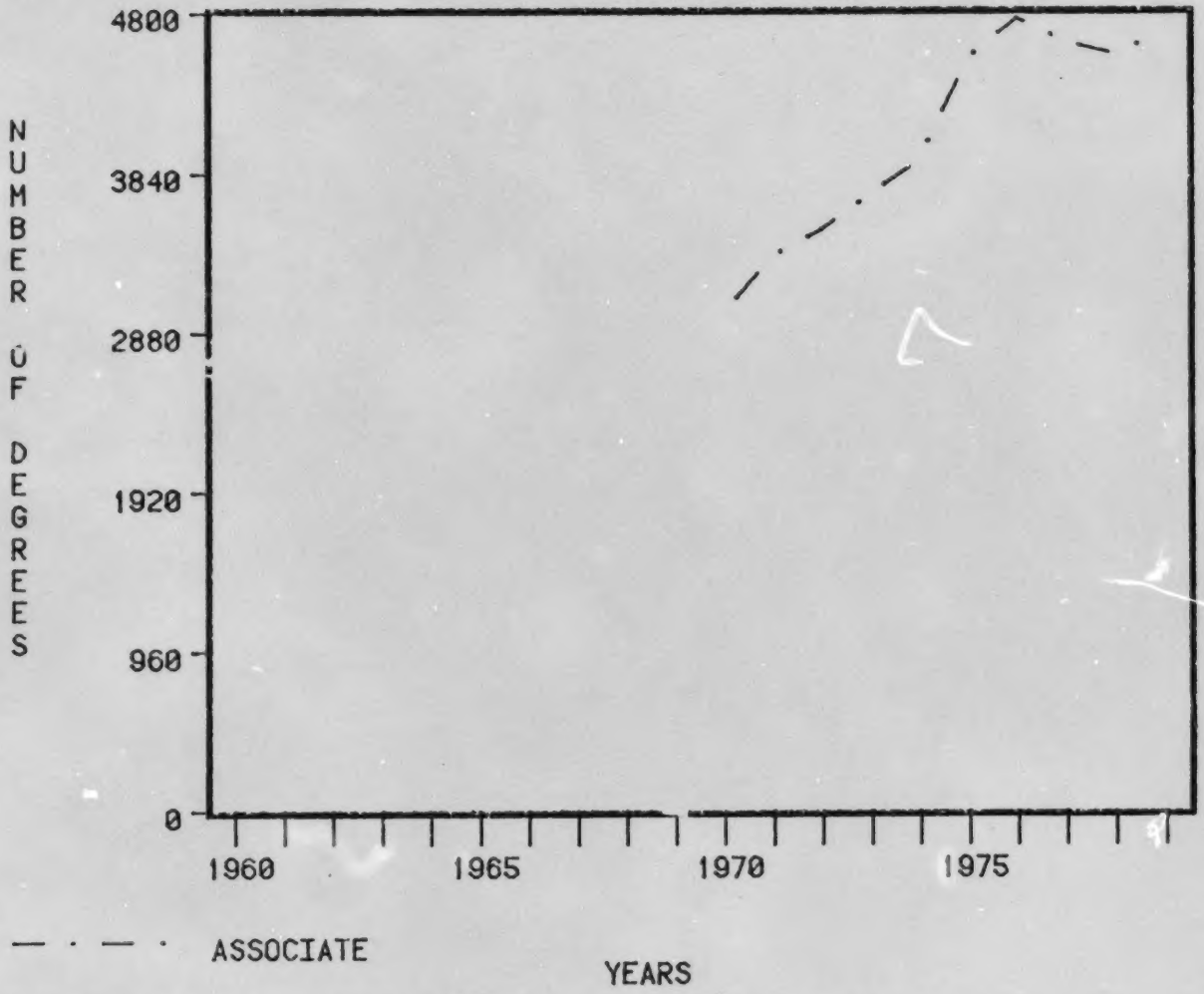
*Includes B. Tech.

Source: NYSED: Postsecondary Information Systems/HEDS and Information Center on Education (DGH Jan. 1982)

FIGURE 6

ASSOCIATE DEGREES IN MECHANICAL AND ENGINEERING TECH.*

NEW YORK STATE 1960-1980



*The Department did not collect data on associate degrees before 1969-1970.

Source: NYSED: Postsecondary Information Systems/HEDS and Information Center on Education (DGH Jan. 1982)

TABLE 18

ASSOCIATE DEGREES IN MECHANICAL AND ENGINEERING TECHNOLOGIES NEW YORK STATE 1970-1980

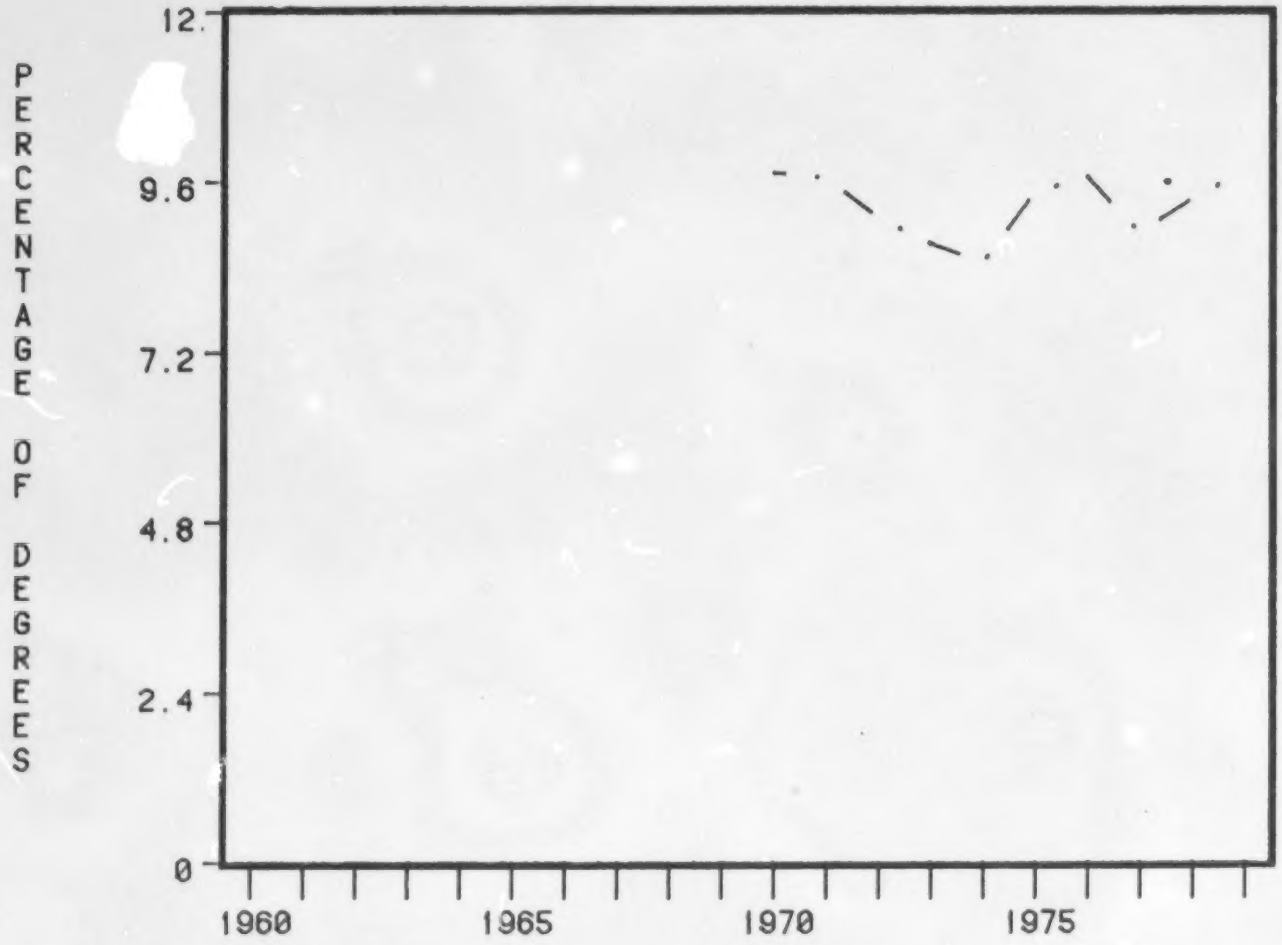
1970-71	3,010
1971-72	3,309
1972-73	3,508
1973-74	3,719
1974-75	3,927
1975-76	4,531
1976-77	4,765
1977-78	4,629
1978-79	4,555
1979-80	4,666

SOURCE: NYSED: Postsecondary Information Systems/HEDS and Information Center on Education (DGH Jan. 1982).

FIGURE 7

ASSOCIATE DEGREES IN ENGINEERING AS A PERCENTAGE OF ASSOCIATE DEGREES*

NEW YORK STATE 1960-1980



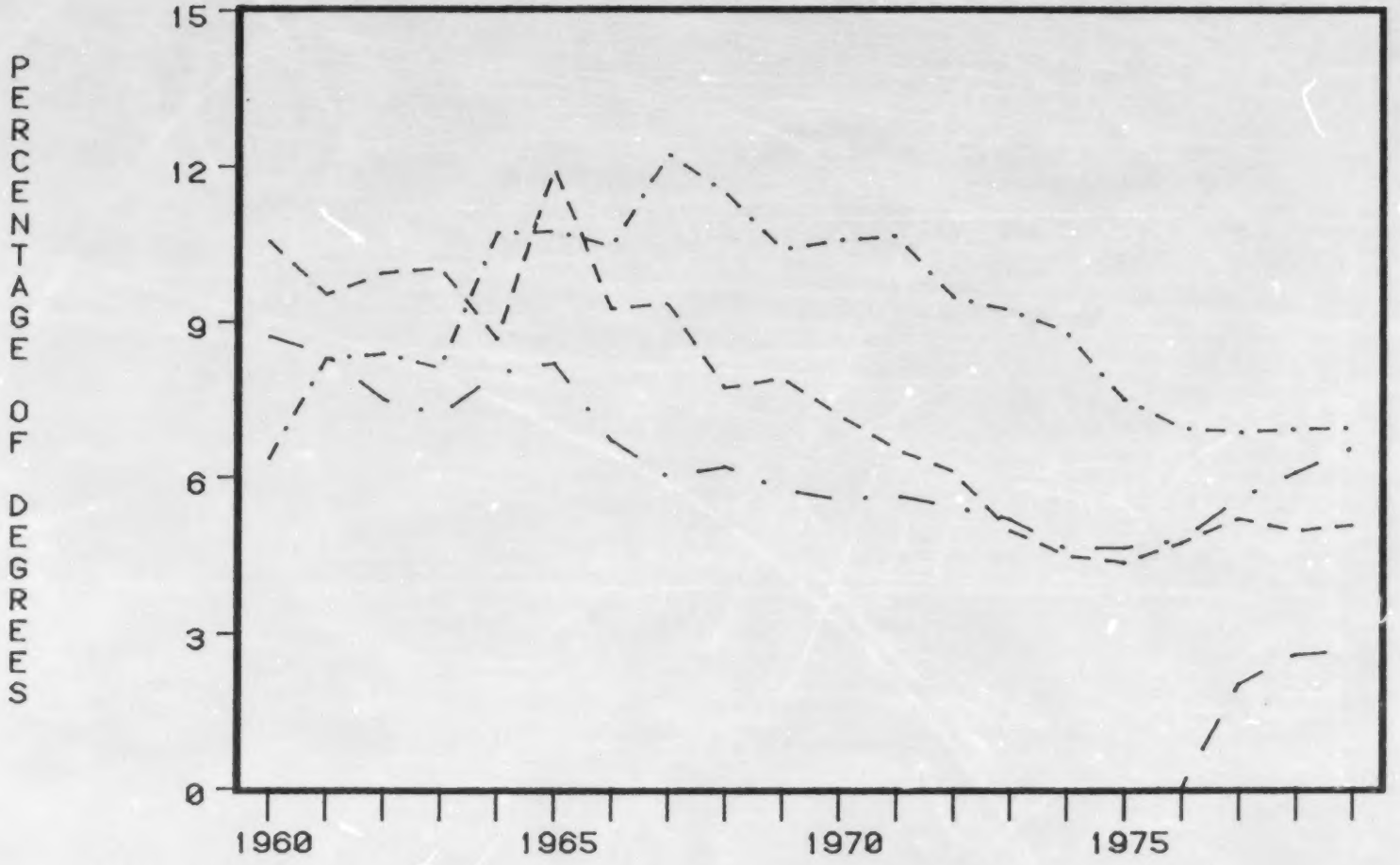
*The Department did not collect data on associate degrees before 1969-1970.

SOURCE: NYSED: Postsecondary Information Systems/HEDS and Information Center on Education (DGH/Jan. 1982).

Figure 8

ENGINEERING DEGREES AS A PERCENTAGE OF DEGREES AWARDED

NEW YORK STATE 1960-1980



SOURCE: NYSED: Postsecondary Information Systems/HEDS and Information Center on Education (DGH/Jan. 1982).
*Includes B. Tech. degrees.

For the baccalaureate, master's, and doctoral degrees in engineering, Table 19 and Figure 9 show New York State degrees reported to the Department as a percentage of all such degrees granted in the U.S., 1960-61 through 1979-80, as reported by the Engineering Manpower Commission (EMC).** (The National Science Foundation and the National Center for Education Statistics also collect data on enrollments and degrees granted; these differ slightly, but not substantially, from EMC figures.) New York's proportion of baccalaureates rose to a high of 11.1 percent in 1965-66, remaining around 10 percent through 1974-75 (except for a drop of about one percentage point in 1969-70 and 1970-71); between 1977-78 and 1979-80 the State's share of bachelor's degrees in engineering fell to its 1960-61 level of around 8.7 percent. New York's share of master's degrees also rose sharply in 1965-66; otherwise it held fairly steady at 12 or 13 percent between 1961-62 and 1972-73, when it began to fall to its 1979-80 level of 9.9 percent. The State's share of doctorates in engineering generally rose and fell between 9.5 and 10.8 percent from 1960-61 through 1974-75, then began to descend to a 1978-80 level around 8.5 percent.

For baccalaureate and doctoral degrees, actual numbers have risen somewhat or held steady between 1977-78 and 1979-80, while percentages fell. It seems, therefore, that institutions elsewhere in the U.S. have been expanding their numbers of graduates at a greater rate than New York's. Between 1975-76 and 1979-80, the actual number of master's degrees granted in New York State curved upward, then down again, while those granted throughout the U.S followed an opposite curve. The EMC's count of engineering degrees awarded in New York State does not tally exactly with the figures reported to the State Education Department. The differences, which are larger for advanced degrees than they are at the baccalaureate level, apparently arise partly from slight differences in the lists of institutions reporting to the two agencies and partly from differences in the actual numbers reported by the same institutions. Looking for a moment at only the EMC figures, it is interesting to note how the top states have ranked over the past six years in numbers of

** The EMC reports 62,935 U.S. engineering baccalaureates in 1981.

Table 19

January 1982

Engineering Degrees: NYS and U.S.

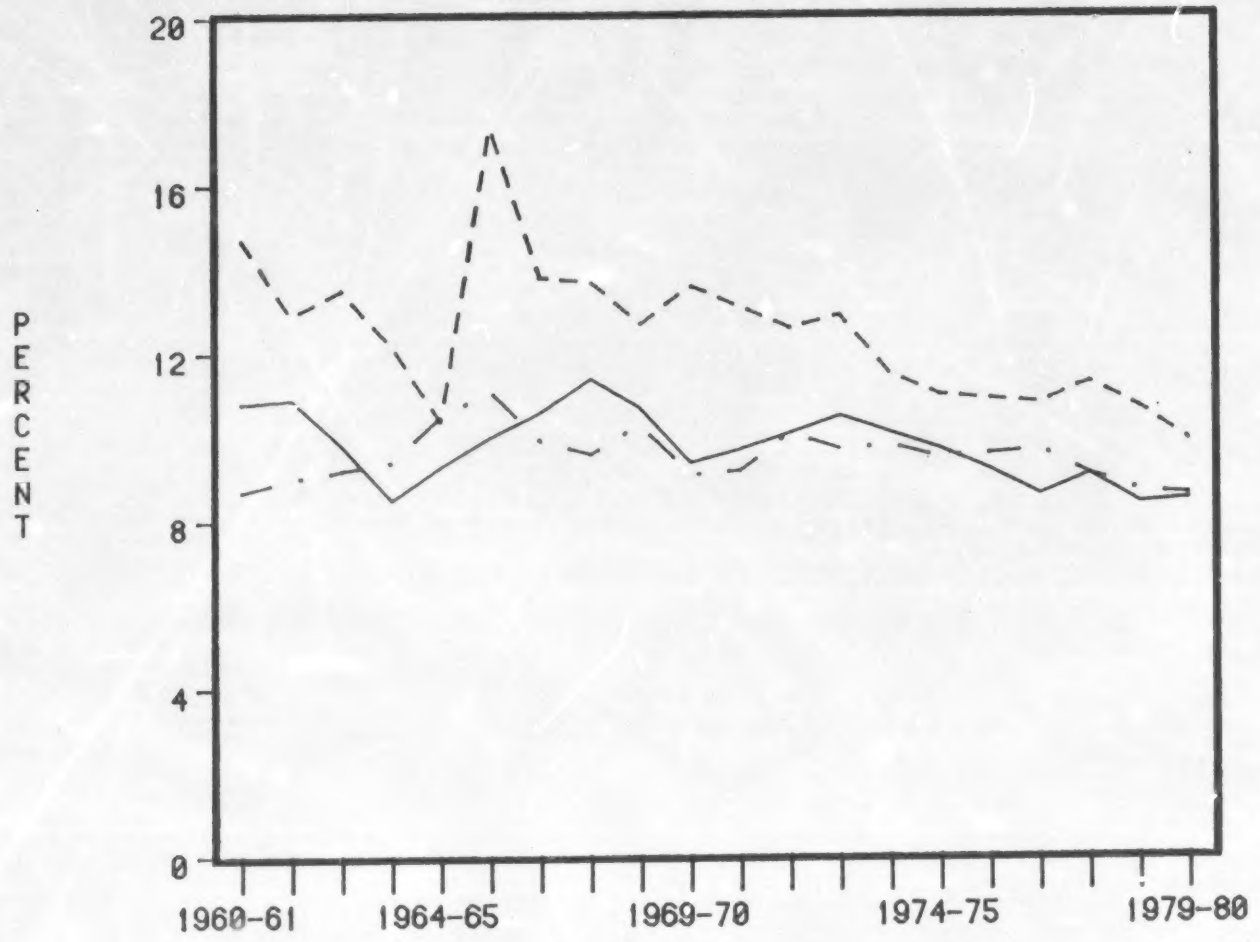
Year	NYS Bach.	% change from previous year	U.S. Bach.	% change from previous year	NYS as % of U.S.	NYS Master's	% change from previous year	U.S. Master's	% change from previous year	NYS as % of U.S.	NYS Doctoral	% change from previous year	U.S. Doctoral	% change from previous year	NYS as % of US
1960-61	3,121		35,863		8.7	1,171		7,977		14.7	102		943		10.8
62	3,131	+0.3	34,735	-3.1	9.0	1,150	-1.8	8,909	+11.7	12.9	131	+28.4	1,207	+28.0	10.9
63	3,069	-2.0	33,458	-3.7	9.2	1,280	+11.3	9,460	+6.2	13.5	135	+3.1	1,378	+14.2	9.8
64	3,324	+8.3	35,226	+5.3	9.4	1,326	+3.6	10,827	+14.5	12.2	144	+6.7	1,693	+22.9	8.5
65	3,865	+16.3	36,691	+4.2	10.5	1,273	-4.0	12,246	+13.1	10.4	197	+36.8	2,124	+25.5	9.3
66	3,968	+2.7	35,815	-2.4	11.1	2,383	+87.2	13,677	+11.7	17.4	230	+16.8	2,303	+8.4	10.0
67	3,584	-9.7	36,186	+1.0	9.9	1,913	-19.7	13,887	+1.5	13.8	276	+20.0	2,614	+13.5	10.6
68	3,631	+1.3	38,002	+5.0	9.6	2,077	+8.6	15,152	+9.1	13.7	333	+20.7	2,933	+12.2	11.4
69	4,121	+13.5	39,972	+5.2	10.3	1,896	-8.7	14,980	-1.1	12.7	361	+8.4	3,387	+15.5	10.7
70	3,895	-5.5	42,966	+7.5	9.1	2,115	+11.6	15,548	+3.8	13.6	340	-5.8	3,620	+6.9	9.4
1971	3,989	+2.4	43,167	+0.5	9.2	2,142	+1.3	16,383	+5.4	13.1	354	+4.1	3,640	+0.6	9.7
72	4,445	+11.4	44,190	+2.4	10.1	2,179	+1.7	17,356	+5.9	12.6	383	+8.2	3,774	+3.7	10.1
73	4,218	-5.1	43,429	-1.7	9.7	2,210	+1.4	17,152	-1.2	12.9	376	-1.8	3,587	-5.0	10.5
74	4,043	-4.1	41,407	-4.7	9.8	1,830	-17.2	15,885	-7.4	11.5	339	-9.8	3,362	-6.3	10.1
75	3,616	-10.6	38,210	-7.7	9.5	1,739	-5.0	15,773	-0.7	11.0	305	-10.0	3,138	-6.7	9.7
76	3,645	+0.8	37,970	-0.6	9.6	1,747	+0.5	16,506	+4.6	10.9	273	-10.5	2,977	-5.1	9.2
77	3,879	+6.4	40,095	+5.6	9.7	1,795	+2.7	16,551	+0.3	10.8	242	-11.4	2,813	-5.5	8.6
78	4,192	+8.1	46,091	+15.0	9.1	1,831	+2.0	16,182	-2.2	11.3	234	-3.3	2,573	-8.5	9.1
79	4,595	+9.6	52,598	+14.1	8.7	1,678	-8.4	15,624	-3.4	10.7	236	+0.9	2,815	+9.4	8.4
1980	4,990	+8.6	58,117	+10.5	8.6	1,673	-0.3	16,927	+8.3	9.9	235	-0.4	2,753	-2.2	8.5

Sources: N.Y. figures - NYSED Postsecondary Information Systems/HEDS and Information Center on Education (DGI Jan. 1982)
U.S. figures - Engineering Manpower Commission of American Association of Engineering Societies

Figure 9

ENGINEERING DEGREES: NYS AS % OF US

1960-61 TO 1979-80



Sources: N.Y. figures - NYSED Postsecondary Information Systems/ HEDS and Information Center on Education (DGH Jan. 1982)
U.S. figures - EMC

engineering degrees granted (Tables 20, 21, and 22). In baccalaureate production, New York has consistently ranked a close second to California (surpassing California in 1979). In 1981, however, the gap between the two states widened to nearly 700 engineering bachelor's degrees (Table 20). In numbers of master's degrees, California and New York have consistently ranked first and second (Table 21); in engineering doctorates, California has ranked first in each of the past six years, with New York second each year except 1979 and 1981 (when it dropped into third place behind Illinois; Table 22). These rankings have held fairly steady over the period despite varying rates of change in the states' populations (Table 23). In fact, although the percentages of U.S. engineering degrees granted in New York have fallen slightly between 1970 and 1980, the State's population has fallen more steeply.

The discussion which follows will examine engineering degrees granted in New York State from several standpoints -- regional and sector shares, proportions of women, minorities, and foreign nationals among degree recipients -- in order to describe the current situation as fully as possible.

2. Degrees Granted by Region

Not all degree recipients remain in New York State after graduating; and an unknown number is brought into the State from elsewhere by the recruiting efforts of New York industry. The State Education Department survey of engineering schools in April 1982 revealed that, at fifteen schools* able to furnish placement data, an average of 53.4 percent of engineering baccalaureates who accepted positions in their field did so in New York State; at four institutions** with Bachelor of Technology placement figures, an average of

*SUNY at Buffalo, SUNY at Stony Brook, NYS College of Ceramics, NYS College of Agriculture, NYS College of Environmental Science and Forestry, SUNY Maritime College, Cooper Union, Clarkson, Columbia, Hofstra University, Manhattan College, Pratt Institute, Polytechnic Institute of New York, Rensselaer Polytechnic Institute, and Union College. Together, these schools accounted for approximately 70 percent of the bachelor's degrees in engineering granted in New York State in the past two years. Taken together, they had placement figures for about 77 percent of their bachelor's degree graduates.

**SUNY at Binghamton, SUNY College of Technology at Utica/Rome, New York Institute of Technology, and Rochester Institute of Technology. Together, these institutions accounted for approximately 62 percent of B. Tech. degrees granted in the State in the past two years. Taken together, they had placement figures for about 74 percent of their B. Tech. recipients.

Table 20

The Top Twelve States in Engineering Bachelor's Degrees Granted, 1976-1981

State	1976		1977		1978		1979		1980		1981	
	Number	Rank	Number	Rank	Number	Rank	Number	Rank	Number	Rank	Number	Rank
California	3,351	1	3,658	1	4,266	1	4,753	2	5,071	1	5,684	1
New York	3,276	2	3,629	2	4,157	2	4,778	1	4,974	2	4,987	2
Pennsylvania	2,193	5	2,367	4	2,830	3	3,314	3	3,760	3	4,082	3
Texas	2,244	4	2,224	5	2,810	4	3,203	4	3,516	4	3,911	4
Michigan	2,423	3	2,453	3	2,743	5	2,912	5	3,289	5	3,747	5
Massachusetts	1,959	6	2,134	6	2,344	6	2,745	6	2,868	6	3,022	6
Illinois	1,688	7	1,879	7	1,912	7	2,158	8	2,487	7	2,745	7
Ohio	1,502	8	1,635	8	1,746	8	2,186	7	2,414	8	2,622	8
Indiana	1,408	9	1,545	9	1,654	9	1,828	9	2,276	9	2,201	9
Colorado	947	11	1,097	11	1,231	10	1,450	10	1,438	10	1,600	10
Missouri	912	12	974	12	1,101	12	1,286	11	1,414	11	1,417	12
New Jersey	1,057	10	1,134	10	1,148	11	1,273	12	1,329	12	1,422	11

Source: Engineering Manpower Commission, Engineering and Technology Degrees

Table 21

The Top Ten States in Engineering Master's Degrees Granted, 1976-1981

State	1976		1977		1978		1979		1980		1981	
	Number	Rank	Number	Rank	Number	Rank	Number	Rank	Number	Rank	Number	Rank
California	2,786	1	2,725	1	2,671	1	2,613	1	3,000	1	3,088	1
New York	1,824	2	1,881	2	1,591	2	1,492	2	1,171	2	1,836	2
Massachusetts	1,025	3	1,067	3	1,063	3	979	3	1,134	3	1,144	3
Texas	900	4	851	5	886	4	884	4	959	4	978	4
Ohio	847	6	846	6	810	7	785	8	942	5	977	5
Pennsylvania	864	5	864	4	829	5	846	5	850	6	888	6
Michigan	762	8	750	8	727	8	832	6	765	8	834	7
Illinois	790	7	814	7	812	6	789	7	842	7	795	8
District of Columbia					370	10	262	17	366	10	437	9
New Jersey	543	9	437	9	441	9	403	9	427	9	402	10
Virginia							358	10				
Indiana	402	10	402	10								

Source: Engineering Manpower Commission, Engineering and Technology Degrees

Table 22

The Top Ten States in Engineering Doctorates Granted, 1976-1981

State	1976		1977		1978		1979		1980		1981	
	Number	Rank	Number	Rank	Number	Rank	Number	Rank	Number	Rank	Number	Rank
California	528	1	483	1	479	1	501	1	502	1	511	1
Illinois	220	3	237	3	189	4	250	2	236	3	269	2
New York	280	2	279	2	233	2	239	3	275	2	267	3
Massachusetts	207	4	203	4	224	3	200	4	200	4	210	4
Pennsylvania	176	5	144	6	133	6	156	5	143	5	144	5
Texas	144	7	147	5	141	5	141	7	139	6	136	6
Ohio	156	6	118	7	119	7	139	8	137	7	116	7
Indiana	108	8	89	8	96	8	94	9	103	8	110	8
Colorado					94	9	74	10	66	10	91	9
Michigan	106	9	82	9			153	6	99	9	91	9
Wisconsin					66	10					75	10
Tennessee	70	10	72	10								

Source: Engineering Manpower Commission, Engineering and Technology Degrees

Table 23

The Top Ten States in Engineering Degrees Granted
Population Changes, 1970-1980

State	Population 1970 Census	Population 1980 Census	Change 1970-1980	Percent Change 1970-1980
California	19,953,134	23,668,562	+3,715,428	+18.6%
New York	18,241,266	17,557,288	-683,978	-3.8%
Pennsylvania	11,793,909	11,866,728	+72,819	+0.6%
Texas	11,196,730	14,228,383	+3,031,653	+27.1%
Michigan	8,875,083	9,258,344	+383,261	+4.2%
Massachusetts	5,689,170	5,737,037	+47,867	+0.8%
Illinois	11,113,976	11,418,461	+304,485	+2.8%
Ohio	10,652,017	10,797,419	+145,402	+1.3%
Indiana	5,195,392	5,490,179	+294,787	+5.7%
Colorado	2,207,259	2,888,834	+681,575	+30.8%

Source: U.S. Census Bureau

71.4 percent of those who accepted engineering technology employment remained in the State. At nine institutions* with placement data on master's recipients, about 50 percent of all who found first-time engineering employment in 1980-81 stayed in the State. The institutions also reported the number of master's-degree recipients who were already employed in engineering (presumably in New York State). When these are added, they bring the total remaining in New York to 64 percent. Placement reports for doctorates were too few to give significant results.

Of those employed in New York State, the colleges reported that approximately 35 percent of engineering baccalaureates and 44 percent of master's recipients found employment in the local area (the county in which the college is located and surrounding counties). It is clear that a region's employment demand for engineering graduates is not satisfied by those receiving degrees within its borders, as these percentages and a glance at Tables 24, 25, 26, 27, and 32 will show. (For convenience of comparison with enrollment figures given in the next section, Tables 28, 29, 30, and 31 show degrees at different levels awarded in each Regents Postsecondary Planning Region.)

3. Degrees Granted by Sector

Table 33 gives the numbers of engineering degrees awarded in each postsecondary education sector over a ten-year period. It shows that the State University's share has increased from 14 to 20 percent of baccalaureates conferred in the State, from 9 to 11 percent of master's degrees, and from 9 to 18 percent of the doctorates. The City University's share has shrunk, while the independent sector shows little change in the proportions of degrees it awards except in its share of doctorates, which has dropped from 88 to 77 percent. Table 34 shows that at the associate-degree level, State University and the independent sector have gained in proportions of degrees awarded, while City University and the proprietary sector have lost.

4. Degrees to Women and Minorities

Table 35 (page 71) tracks the engineering baccalaureates awarded to members of underrepresented minority groups and to women in the United States, 1976-1981, according

*SUNY at Buffalo, NYS College of Agriculture, NYS College of Ceramics, NYS College of Environmental Science and Forestry, Clarkson, Columbia, Manhattan College, Rensselaer Polytechnic Institute, and Union College. Together, these schools awarded about 46 percent of master's degrees in the State over the past two years. They had placement figures for about 63 percent of master's degree recipients.

Table 24

Number of Engineering Bachelor's Degrees Awarded in each Vocational Education Planning Region

Region	1969-1970	1970-1971	1971-1972	1972-1973	1973-1974	1974-1975	1975-1976	1976-1977	1977-1978	1978-1979	1979-1980
1. Nassau-Suffolk	216	207	381	272	173	198	263	235	153	290	331
2. New York City	1,720	1,637	1,774	1,708	1,632	1,285	1,154	1,136	1,342	1,343	1,508
3. Mid-Hudson	0	0	0	0	0	0	0	0	0	0	0
4. Upper Hudson	513	503	563	540	510	504	606	620	678	789	820
5. L. Champlain-L. George	0	0	0	0	0	0	0	0	0	0	0
6. Black River-St. Lawrence	258	298	299	348	356	307	295	394	484	458	538
7. Upper Mohawk Valley	0	0	0	0	0	0	0	0	0	0	0
8. Southern Tier East	0	0	0	0	0	0	0	0	0	0	0
9. Central	589	566	700	645	723	699	674	739	787	847	888
10. Genesee-Finger Lakes	232	384	259	268	289	254	245	260	314	346	353
11. Southern Tier Central	0	0	0	0	0	0	0	0	0	0	0
12. Western	281	331	403	357	288	324	357	434	369	451	464
13. Southern Tier West	86	63	66	81	80	45	51	61	65	71	88
State Total	3,895	3,989	4,445	4,219	4,051	3,616	3,645	3,879	4,192	4,595	4,990

Source: NYSED, Bureau of Postsecondary Planning, 1982

Table 25

Number of Bachelor's Degrees in Engineering Technology
Awarded in Each Vocational Education Planning Region

	Region	1972-1973	1973-1974	1974-1975	1975-1976	1976-1977	1977-1978	1978-1979	1979-1980
1.	Nassau-Suffolk	7	20	40	9	22	103	108	102
2.	New York City	90	95	81	145	118	111	150	150
3.	Mid-Hudson	0	0	0	0	0	0	0	0
4.	Upper Hudson	0	0	0	0	0	0	0	0
5.	L. Champlain-L. George	0	0	0	0	0	0	0	0
6.	Black River-St. Lawrence	0	0	0	0	0	0	0	0
7.	Upper Mohawk Valley	0	0	0	0	0	0	1	14
8.	Southern Tier East	0	3	16	33	32	44	25	32
9.	Central	0	0	0	0	0	0	0	0
10.	Genesee-Finger Lakes	133	130	85	138	97	178	167	197
11.	Southern Tier Central	0	0	0	0	0	0	0	0
12.	Western	19	60	10	6	28	151	174	118
13.	Southern Tier West	0	0	0	0	0	0	0	0
State Total		249	308	232	331	297	587	625	613

Source: NYSED, Bureau of Postsecondary Planning, 1982

Table 26

Number of Master's Degrees in Engineering Awarded in Each Vocational Education Planning Region

Region	1969-1970	1970-1971	1971-1972	1972-1973	1973-1974	1974-1975	1975-1976	1976-1977	1977-1978	1978-1979	1979-1980
1. Nassau-Suffolk	154	154	160	161	102	70	135	160	87	134	125
2. New York City	1,109	1,141	1,079	1,171	883	857	770	798	822	673	655
3. Mid-Hudson*	0	0	0	0	0	0	0	0	0	46	72
4. Upper Hudson*	268	272	278	289	278	282	293	268	322	277	295
5. L. Champlain-L. George	0	0	0	0	0	0	0	0	0	0	0
6. Black River-St. Lawrence	37	48	74	40	43	50	53	54	76	42	46
7. Upper Mohawk Valley	0	0	0	0	0	0	0	0	0	0	15
8. Southern Tier East*	0	0	0	0	0	0	0	0	0	0	13
9. Central	357	356	392	375	359	311	295	340	338	281	268
10. Genesee-Finger Lakes	72	67	93	61	81	84	78	74	93	83	80
11. Southern Tier Central	0	0	0	0	0	0	0	0	0	0	0
12. Western	108	98	97	103	81	76	110	89	84	106	94
13. Southern Tier West	10	6	6	10	3	9	13	12	9	13	10
State Total	2,115	2,142	2,179	2,210	1,830	1,739	1,747	1,795	1,831	1,678	1,673

*If Syracuse University can furnish numbers of engineering master's degrees awarded in Regions 3, 4, and 8, these regional totals and percents will change.

Source: NYSED, Bureau of Postsecondary Planning, 1982

Table 27

Number of Doctorates in Engineering Awarded in Each Vocational Education Planning Region

Region	1969-1970	1970-1971	1971-1972	1972-1973	1973-1974	1974-1975	1975-1976	1976-1977	1977-1978	1978-1979	1979-1980
1. Nassau-Suffolk	13	6	14	13	17	11	13	20	14	12	11
2. New York City	165	172	183	138	118	136	107	79	76	81	63
3. Mid-Hudson	0	0	0	0	0	0	0	0	0	0	2
4. Upper Hudson	39	47	45	50	54	24	20	32	23	23	33
5. L. Champlain-L. George	0	0	0	0	0	0	0	0	0	0	0
6. Black River-St. Lawrence	1	1	5	11	11	13	5	5	6	5	7
7. Upper Mohawk Valley	0	0	0	0	0	0	0	0	0	0	0
8. Southern Tier East	0	0	0	0	0	0	0	0	0	0	0
9. Central	87	92	99	110	92	82	84	68	69	67	81
10. Genesee-Finger Lakes	21	19	18	25	19	15	17	13	16	24	13
11. Southern Tier Central	0	0	0	0	0	0	0	0	0	0	0
12. Western	13	13	14	24	26	23	24	23	26	22	23
13. Southern Tier West	1	4	5	5	2	1	3	2	4	2	2
State Total	340	354	383	376	339	305	273	242	234	236	235

Source: NYSED, Bureau of Postsecondary Planning, 1982

Table 28

Number of Bachelor's Degrees in Engineering Granted in Each Regents Postsecondary Education Region, 1970-1980

Region:	1 Western	2 Genesee Valley	3 Central	4 Northern	5 Northeast	6 Mid-Hudson	7 New York City	8 Long Island	State Total
Year									
1969-70	357	232	589	258	513	0	1,720	216	3,895
1970-71	394	384	566	298	503	0	1,637	207	3,989
1971-72	469	259	700	299	563	0	1,774	381	4,445
1972-73	438	268	645	348	540	0	1,708	272	4,219
1973-74	368	289	723	356	510	0	1,632	173	4,051
1974-75	369	254	699	307	504	0	1,285	198	3,616
1975-76	408	245	674	295	606	0	1,154	263	3,645
1976-77	495	260	739	394	620	0	1,136	235	3,879
1977-78	434	314	787	484	678	0	1,342	153	4,192
1978-79	522	346	847	458	789	0	1,343	290	4,595
1979-80	552	353	888	538	820	0	1,508	331	4,990

Source: NYSED Postsecondary Information Systems/HEDS

Table 29

Number of Bachelor's Degrees in Engineering Technology (0925) Granted in Each Regents Postsecondary Education Region, 1973-1980

Region:	1 Western	2 Genesee Valley	3 Central	4 Northern	5 Northeast	6 Mid-Hudson	7 New York City	8 Long Island	State Total
Year									
1972-73	19	133	-	-	-	-	90	7	249
1973-74*	60	130	3	-	-	-	95	20	308
1974-75	10	85	16	-	-	-	81	40	232
1975-76	6	138	33	-	-	-	145	9	331
1976-77	28	97	32	-	-	-	118	22	297
1977-78	151	178	44	-	-	-	111	103	587
1978-79	174	167	25	-	1	-	150	108	625
1979-80	118	197	32	-	14	-	150	102	613

*Estimate based on 1973 estimates by institutions of degrees to be granted in 1974; actual figures not available.

Source: NYSED Postsecondary Information Systems/HEDS

Table 30

Number of Master's Degrees in Engineering Granted in Each Regents Postsecondary Education Region, 1970-1980

Region: / Year	1 Western	2 Genesee Valley	3 Central	4 Northern	5 Northeast	6 Mid-Hudson	7 New York City	8 Long Island	State Total
1969-70	118	72	357	37	268	0	1,109	154	2,115
1970-71	104	67	356	48	272	0	1,141	154	2,142
1971-72	103	93	392	74	278	0	1,079	160	2,179
1972-73	113	61	375	40	289	0	1,171	161	2,210
1973-74	84	81	359	43	278	0	883	102	1,830
1974-75	85	84	311	50	282	0	857	70	1,739
1975-76	123	78	295	53	293	0	770	135	1,747
1976-77	101	74	340	54	268	0	798	160	1,795
1977-78	93	93	338	76	322	0	822	87	1,831
1978-79	119	83	297	42	284	46	673	134	1,678
1979-80	104	80	281	46	310	72	655	125	1,673

Source: NYSED Postsecondary Information Systems/HEDS

Table 31

Number of Doctoral Degrees in Engineering Granted in Each Regents Postsecondary Education Region, 1970-1980

Region: / Year	1 Western	2 Genesee Valley	3 Central	4 Northern	5 Northeast	6 Mid-Hudson	7 New York City	8 Long Island	State Total
1969-70	14	21	87	1	39	0	165	13	340
1970-71	17	19	92	1	47	0	172	6	354
1971-72	19	18	99	5	45	0	183	14	383
1972-73	29	25	110	11	50	0	138	13	376
1973-74	28	19	92	11	54	0	118	17	339
1974-75	24	15	82	13	24	0	136	11	305
1975-76	27	17	84	5	20	0	107	13	273
1976-77	25	13	68	5	32	0	79	20	242
1977-78	30	16	69	6	23	0	76	14	234
1978-79	24	24	67	5	23	0	81	12	236
1979-80	25	13	81	7	33	2	63	11	235

Source: NYSED Postsecondary Information Systems/HEDS

Table 32

Number of Job Openings in "Engineering, Technical" Projected Annually in Each Vocational Education Planning Region of New York State

Vocational Education Planning Region	Employment 1974	1982 Projected	1985 Projected	Average Annual Openings 1974-1985
1. Nassau-Suffolk	17,629	19,291	19,968	1,823
2. New York City	29,698	29,133	28,899	2,292
3. Mid-Hudson	10,099	11,764	12,461	2,292
4. Upper Hudson	7,744	8,329	8,572	742
5. Lake Champlain-Lake George	485	551	579	52
6. Black River-St. Lawrence	422	499	532	50
7. Upper Mohawk Valley	2,375	2,305	2,276	178
8. Southern Tier East	4,138	4,316	4,390	378
9. Central	5,307	5,426	5,478	453
10. Genesee-Finger Lakes	11,310	11,730	11,906	1,023
11. Southern Tier Central	1,160	1,273	1,319	119
12. Western	6,769	6,799	6,812	577
13. Southern Tier West	924	1,036	1,083	100
State Total	98,064	102,455	104,294	8,965

Source: NYS Department of Labor

Table 33

Engineering Degrees and Bachelor of Technology Degrees Conferred in New York State by Sector, 1970-1980

Year	SUNY Number	SUNY Percent	CUNY Number	CUNY Percent	Independent Number	Independent Percent	Total
1969-1970							
Bachelor's*	561	14.4%	450	11.6%	2,884	74.0%	3,895
Master's	193	9.1%	107	5.1%	1,815	85.8%	2,115
Doctorates	30	8.8%	12	3.5%	298	87.7%	340
1970-1971							
Bachelor's*	575	14.4%	407	10.2%	3,007	75.4%	3,989
Master's	148	6.9%	108	5.0%	1,886	88.1%	2,142
Doctorates	33	9.3%	6	1.7%	315	89.0%	354
1971-1972							
Bachelor's*	714	16.1%	486	10.9%	3,245	73.0%	4,445
Master's	201	9.2%	93	4.3%	1,885	86.5%	2,179
Doctorates	45	11.8%	15	3.9%	323	84.3%	383
1972-1973							
Bachelor's*	682	15.3%	490	11.0%	3,296	73.7%	4,468
Master's	200	9.1%	136	6.1%	1,874	84.8%	2,210
Doctorates	51	13.6%	6	1.6%	319	84.8%	376
1973-1974							
Bachelor's*	636	14.6%	443	10.2%	3,280	75.2%	4,359
Master's	131	7.2%	93	5.1%	1,606	87.7%	1,830
Doctorates	49	14.4%	7	2.1%	283	83.5%	339
1974-1975							
Bachelor's*	586	15.2%	403	10.5%	2,859	74.3%	3,848
Master's	141	8.1%	78	4.5%	1,520	87.4%	1,739
Doctorates	42	13.8%	11	3.6%	252	82.6%	305
1975-1976							
Bachelor's*	660	16.7%	363	9.2%	2,926	74.1%	3,949
Master's	228	13.0%	76	4.4%	1,443	82.6%	1,747
Doctorates	45	16.5%	8	2.9%	220	80.6%	273

Year	SUNY Number	SUNY Percent	CUNY Number	CUNY Percent	Independent Number	Independent Percent	Total
1976-1977							
Bachelor's*	757	18.1%	373	8.9%	3,046	73.0%	4,176
Master's	245	13.7%	54	3.0%	1,496	83.3%	1,795
Doctorates	50	20.7%	9	3.7%	183	75.6%	242
1977-1978							
Bachelor's*	886	18.5%	364	7.6%	3,529	73.8%	4,779
Master's	174	9.5%	35	1.9%	1,622	88.6%	1,831
Doctorates	49	20.9%	5	2.1%	180	76.9%	234
1978-1979							
Bachelor's*	1,073	20.6%	377	7.2%	3,770	72.2%	5,220
Master's	204	12.2%	32	1.9%	1,442	85.9%	1,678
Doctorates	46	19.5%	10	4.2%	180	76.3%	236
1979-1980							
Bachelor's*	1,120	20.0%	336	6.0%	4,147	74.0%	5,603
Master's	186	11.1%	37	2.2%	1,450	86.7%	1,673
Doctorates	43	18.3%	10	4.3%	182	77.4%	235

*Includes B. Tech.

Source: NYSED HEDS

Table 34

Associate Degrees in Engineering Science and Mechanical and Engineering Technologies Conferred in New York State by Sector, 1976-1980

Year	SUNY Number	SUNY Percent	CUNY Number	CUNY Percent	Independent Number	Independent Percent	Proprietary Number	Proprietary Percent	Total
1975-76									
Mech./Engr. Technologies	3,202	70.7%	790	17.4%	344	7.6%	195	4.3%	4,531
1976-77									
Mech./Engr. Technologies	3,404	71.4%	799	16.8%	382	8.0%	180	3.8%	4,765
1977-78									
Engr. Science	434	93.1%	32	6.9%	-	-	-	-	466
Mech./Engr. Technologies	3,408	73.6%	715	15.4%	421	9.0%	85	1.8%	4,629
1978-79									
Engr. Science	486	93.6%	33	6.4%	-	-	-	-	519
Mech./Engr. Technologies	3,417	75.0%	611	13.4%	465	10.2%	62	1.4%	4,555
1979-80									
Engr. Science	498	92.4%	41	7.6%	-	-	-	-	539
Mech./Engr. Technologies	3,549	76.0%	485	10.4%	573	12.3%	61	1.3%	4,668

to the Engineering Manpower Commission.** Table 36 displays this information for New York State. It is immediately obvious that, of these groups, only women have increased their share of degrees significantly over the six-year period, both in the State and in the nation. Nationally their share has risen yearly, from 3.6 percent in 1976 to 10.4 percent in 1981. In New York, the share of engineering baccalaureates earned by women kept pace with the U.S. rise until 1981, when it apparently fell back to 8.3 percent -- below the levels for the previous two years. This development bears watching in the future. If it is not a quirk caused by some factor such as a change or error in reporting, it might mean that increased attention is needed to recruit and retain women for engineering programs in the State.

The percentage of degrees awarded to all minorities taken together has remained virtually steady. Of the three minority groups, American Indians have consistently earned about 0.1 percent of engineering baccalaureates. For Hispanic-Americans the percentage of U.S. and New York engineering baccalaureates has held fairly steady at around 2 percent. Nationally, the share earned by blacks (approximately 2 percent) has risen very slightly; in New York, this share (approximately 3 percent) has slightly declined.

Representation of women, as well as minorities, has remained very low in numbers of graduate degrees earned. For example, women, the largest of the groups, earned 1.9 percent of engineering doctorates in 1976 and 2.2 percent in 1981.

5. Graduate Degrees to Foreign Nationals

In recent years, as engineering baccalaureate degrees have risen steadily in number, graduate degrees have held approximately steady (Table 19, page 50). The percentage of graduate degrees, and particularly of doctorates, earned in the U.S. by foreign nationals has become a topic of concern, since many of these leave the country upon graduation, thus decreasing the pool of manpower with this specialized training. Table 37 shows the numbers of foreign graduate-degree recipients reported to the EMC in the past six years and the

**Figures for these groups and for foreign nationals in EMC publications prior to 1976 do not represent total counts for the nation or the states.

Table 35

U.S.
Bachelor's Degrees in Engineering Awarded to Women and Members of Minority Groups
1976-1981

Group	1975-76 No.	1975-76 % of Total	1976-77 No.	1976-77 % of Total	1977-78 No.	1977-78 % of Total	1978-79 No.	1978-79 % of Total	1979-80 No.	1979-80 % of Total	1980-81 No.	1980-81 % of Total	Change 1976-80 No.	Change 1976-80 Percent	Change 1976-81 No.	Change 1976-81 Percent
Blacks	777	2.0%	844	2.1%	894	1.9%	1,076	2.0%	1,320	2.3%	1,445	2.3%	+543	+69.9%	+668	+86.0%
Hispanics	1,019	2.7%	1,035	2.6%	1,072	2.3%	1,245	2.4%	1,332	2.3%	1,513	2.4%	+313	+30.7%	+494	+48.5%
Amer. Indian	41	0.1%	36	0.1%	37	0.1%	59	0.1%	60	0.1%	90	0.1%	+19	+46.3%	+49	+119.5%
All Minorities	1,837	4.8%	1,915	4.8%	2,003	4.3%	2,380	4.5%	2,712	4.7%	2,850	4.5%	+875	+47.6%	+1013	+55.1%
Women	1,376	3.6%	1,961	4.9%	3,280	7.1%	4,716	9.0%	5,680	9.8%	6,557	10.4%	+4,304	+312.8%	+5181	+376.5%
U.S. -All Baccalaureates	37,970		40,095		46,091		52,598		58,117		62,935		+20,147	+53.1%	+24,425	+64.3%
Percent change year to year			+5.6%		+15.0%		+14.1%		+10.5%		+8.3%					

Source: Engineering Manpower Commission

Table 36

New York State
Bachelor's Degrees in Engineering Awarded to Women and Members of Minority Groups
1976-1981

Group	1975-76 No.	1975-76 % of Total	1976-77 No.	1976-77 % of Total	1977-78 No.	1977-78 % of Total	1978-79 No.	1978-79 % of Total	1979-80 No.	1979-80 % of Total	1980-81 No.	1980-81 % of Total	Change 1976-80 No.	Change 1976-80 Percent	Change 1976-81 No.	Change 1976-81 Percent
Blacks	121	3.7%	142	3.9%	150	3.6%	112	2.3%	147	3.0%	151	3.0%	+26	+21.5%	+30	+24.8%
Hispanics	64	2.0%	52	1.4%	85	2.0%	96	2.0%	93	1.9%	116	2.3%	+29	+45.3%	+52	+81.3%
Amer. Indian	4	0.1%	5	0.1%	2	0.1%	3	0.1%	7	0.1%	5	0.1%	+3	+75.0%	+1	+25.0%
All Minorities	189	5.8%	199	5.5%	237	5.7%	211	4.4%	247	5.0%	272	5.5%	+58	+30.7%	+83	+43.9%
Women	118	3.6%	199	5.5%	275	6.6%	452	9.5%	490	9.9%	416	8.3%	+372	+315.2%	+298	+252.5%
NYS-All Baccalaureates	3,276		3,629		4,157		4,778		4,974		4,987		+1,698	+51.8%	+1711	+52.2%
Percent change year to year			+10.8%		+14.5%		+14.9%		+4.1%		+2.6%					

Source: Engineering Manpower Commission

Table 37

U.S. and New York State
Graduate Degrees Awarded to Foreign Nationals, 1976-1981

	1975-76		1976-77		1977-78		1978-79		1979-80		1980-81	
	No.	Percent of all Awarded	No.	Percent of all Awarded	No.	Percent of all Awarded	No.	Percent of all Awarded	No.	Percent of all Awarded	No.	Percent of all Awarded
U.S.												
Master's	3,628	22.0%	3,749	22.7%	3,597	22.2%	3,944	25.2%	4,402	26.0%	4,589	26.0%
Doctorates	1,060	35.6%	995	35.4%	874	34.0%	929	33.0%	982	35.7%	1,054	37.1%
New York State												
Master's	356	19.5%	301	16.0%	293	18.4%	389	26.1%	396	22.4%	433	23.6%
Doctorates	134	47.9%	97	34.8%	81	34.8%	82	34.3%	118	42.9%	103	38.6%

Source: Engineering Manpower Commission

percentages these represent of all graduate degrees awarded in the State and the nation. Overall New York institutions grant a somewhat smaller share of master's degrees to foreign nationals, and a larger share of doctorates, than do U.S. engineering schools as a whole:

Average share of degrees awarded to foreign nationals, 1976-1981

	Master's	Doctorates
U.S.	24%	35%
New York State	21%	39%

Summary

New York State has lost population over the decade just past. Although engineering degrees granted in the State have also declined as a percentage of the U.S. total, they have not declined proportionally to the population loss. Once they receive their degrees, about 53 percent of New York's engineering graduates who accept engineering positions, and 71 percent of the bachelors of technology, remain in the State. Supply of graduates and employer demand for engineers (measured by job openings into the field) cannot be matched on a regional, or even a statewide, basis due to out-migration and nationwide recruiting.

Among the State's sectors of higher education, the independent institutions currently grant approximately 74 percent of all bachelor's degrees in engineering and engineering technology; State University, approximately 20 percent; and City University, 6 percent. Of master's degrees, 87 percent are granted in the independent sector, 11 percent by SUNY campuses, and 2 percent by CUNY. For doctorates the shares are a little more than 77 percent in the independent sector, 18 percent by SUNY, and 4 percent by CUNY. About 12 percent of associate degrees in mechanical and engineering technologies and none of those in engineering science are conferred in the independent sector, 76 and 92 percent (respectively) by SUNY campuses, 10 percent and 8 percent by CUNY, and one percent of all

associate degrees (none in engineering science) in the proprietary sector.

In New York and nationwide, women have increased their share of engineering baccalaureates (but not of graduate degrees) significantly over the past six years. Blacks, Hispanic-Americans, and American Indians, taken together, have remained at slightly below 5 percent of U.S. engineering baccalaureates -- slightly above 5 percent in New York -- during this period. Representation of women and minorities among graduate-degree recipients has remained low. New York awards 39 percent of its engineering doctorates (and 21 percent of master's degrees in engineering) to foreign nationals; nationwide these percentages have been 35 percent of doctorates, 24 percent of master's degrees in recent years.

Engineering Enrollments: New York State

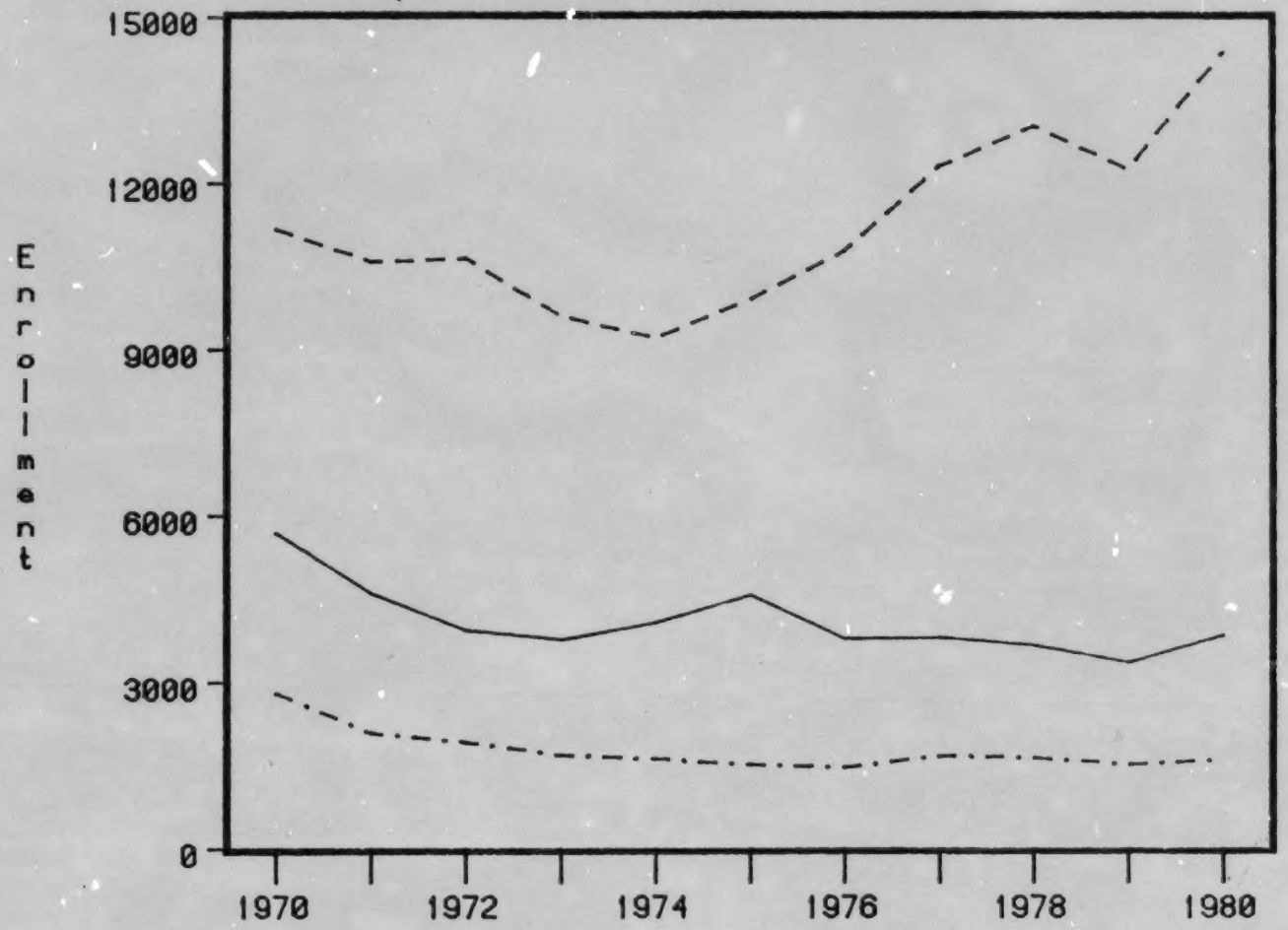
I. New York in the National Context

Degrees granted arise, of course, out of enrollments. These have been on the rise, in New York and nationwide, except for doctoral enrollments. Figures 10 and 11 show New York State degree-credit enrollments in engineering in numbers and as a proportion of total enrollments, 1970-1979. Table 38 shows recent enrollments in New York's associate-degree programs in mechanical and engineering technologies. Over the ten years shown, such enrollments have increased, on the average, by 5.3 percent per year.

The Engineering Manpower Commission historical summary of U.S. engineering enrollments in the past decade is given in Table 39. It shows that, after declining between 1970 and 1973, the number of full-time undergraduates rose sharply in 1975, 1976, and 1977, then at less rapid rates between 1976 and 1980, the most recent year for which EMC enrollment figures have been published (Table 40, page 80). Total full-time undergraduate engineering enrollment rose by 57.6 percent in the 11 years. In the same period, master's-degree enrollments rose by 28.7 percent, while full-time doctoral enrollments were down by 2.3 percent. A large proportion of graduate students are part-time; the EMC gives a combined

Fig.10: NYS ENROLLMENT IN ENGINEERING *

By Level: Fall 1970 to Fall 1980

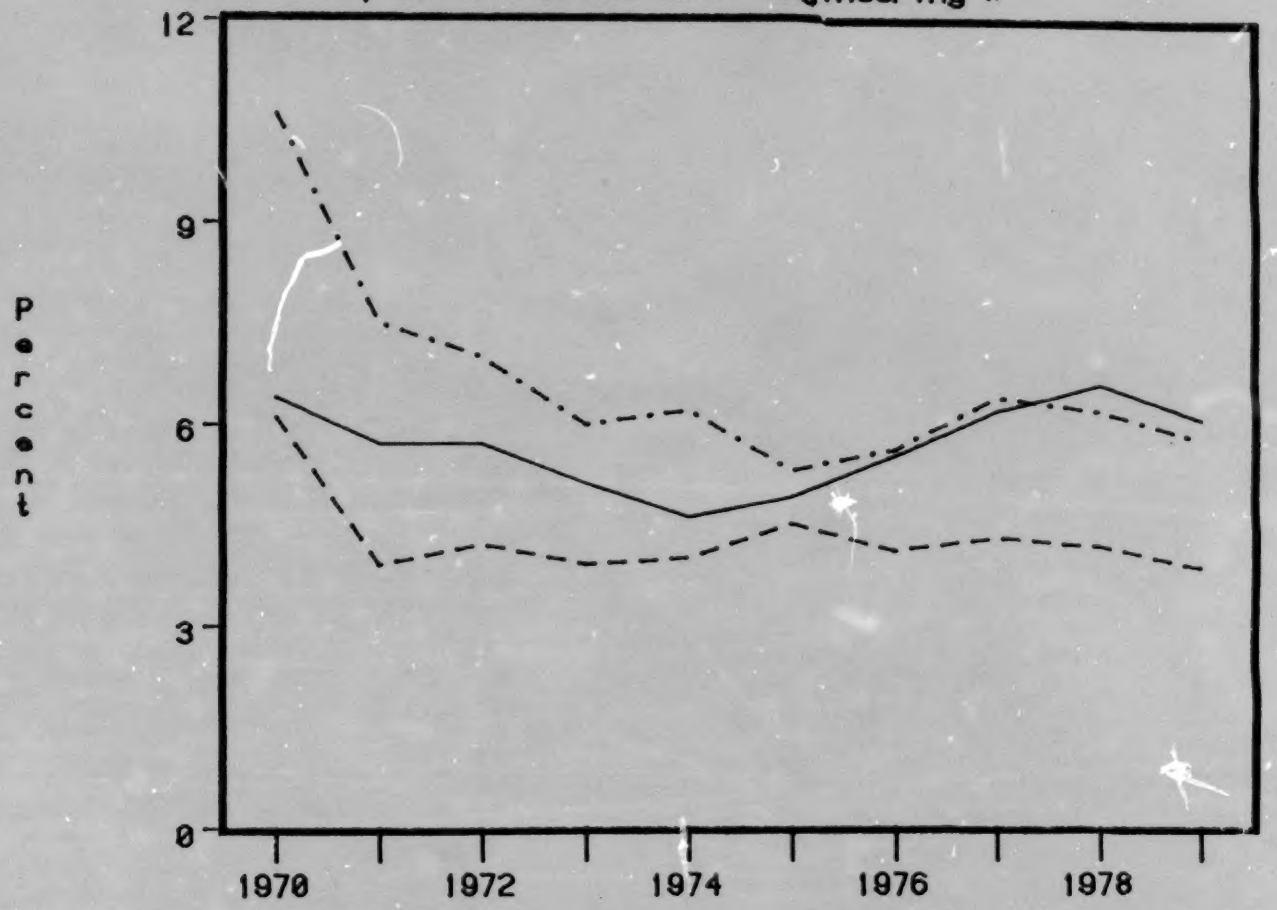


Source: NYSED, Postsecondary Information Systems/HEDS (CD/Jan. 1982)

* Includes B. Tech.

Fig. 11: NYS ENROLLMENT SHARES - 1970 TO 1979

By Level - HEGIS 0900: Engineering *



Source: NYSED, Postsecondary Research and Information Systems/HEDS (CD/Jan. 1982)

* Includes B. Tech. degrees.

April 1982

Table 38

NYS Two-Year (Associate Level) Degree-Credit Enrollment
Mechanical & Engineering Technologies

Year	Enrollment	Change from previous year	
		Number	Percent
1971	17,207		
1972	16,944	-263	-1.5
1973	18,532	+1588	+9.4
1974	20,572	+2040	+11.0
1975	22,015	+1443	+7.0
1976	23,017	+1002	+4.6
1977	24,632	+1615	+7.0
1978	23,709	-923	-3.7
1979	24,779	+1070	+4.5
1980	27,052	+2273	+9.2

Source: NYSED Postsecondary Information Systems/HEDS

Table 39

HISTORICAL SUMMARY
ENGINEERING ENROLLMENTS IN FALL, 1980
As Compared With Earlier Years

	Fall 1970	Fall 1971	Fall 1972	Fall 1973	Fall 1974	Fall 1975	Fall 1976	Fall 1977	Fall 1978	Fall 1979	Fall 1980
Engineering Students											
Freshman Year, Full-Time	71,661	58,566	52,100	51,925	63,444	75,343	82,250	88,780	95,805	103,724	110,149
Sophomore Year, Full-Time	53,419	47,948	42,272	40,519	45,935	55,891	63,003	70,326	72,150	78,594	84,982
Junior Year, Full-Time	49,855	48,543	45,874	41,673	43,007	49,338	56,835	64,721	69,816	74,928	80,024
Senior Year, Full-Time	51,983	51,377	49,895	48,366	44,538	47,070	51,692	60,109	68,260	77,823	84,442
Fifth Year, Full-Time	4,812	4,391	4,586	4,222	4,175	3,737	4,055	5,312	5,206	5,419	5,520
TOTAL FULL-TIME UNDERGRADS	231,730	210,825	194,727	186,705	201,099	231,379	257,835	289,248	311,237	340,488	365,117
Part-Time Undergraduates	18,445	18,222	14,149	15,692	16,689	17,041	19,844	20,634	22,843	25,811	32,227
Master's Degree, Full-Time*	23,216	22,405	22,877	22,588	21,999	26,004	25,516	26,876	26,060	27,923	29,870
Doctor's Degree, Full-Time	14,802	14,100	13,460	11,904	10,628	11,281	10,963	12,359	12,321	13,461	14,465
TOTAL FULL-TIME GRADUATE STUDENTS	38,018	36,505	36,337	34,492	32,627	37,285	36,479	39,235	38,381	41,384	44,335
Part-Time Grad Students	30,802	27,302	24,940	26,114	27,572	27,173	26,842	25,065	24,133	25,768	28,250
Number of Schools	275	282	283	285	282	291	289	289	276	286	287
Number of Schools with at least one curricula accredited by ABET.										239	246

*Includes Engineer (professional) degrees.

Source: EMC, Engineering Enrollments Fall, 1980

Table 40
Change in Full-Time Engineering Enrollments Year by Year,
U.S., 1970-1980, as numbers and percentages

	1971 over '70	1972 over '71	1973 over '72	1974 over '73	1975 over '74	1976 over '75	1977 over '76	1978 over '77	1979 over 78	1980 over '79
Undergraduate F.T. Enrollments										
Change/Yr.										
No.	-20,905	-16,098	- 8,022	+14,394	+30,280	+26,456	+31,413	+21,989	+29,251	+24,629
%	- 9.0	- 7.6	- 4.1	+ 7.7	+ 15.1	+ 11.4	+ 12.2	+ 7.6	+ 9.4	+ 7.2
Freshmen F.T. Enrollments										
Change/Yr.										
No.	-13,095	- 6,466	- 175	+11,519	+11,899	+ 6,907	+ 6,530	+ 7,025	+ 7,919	+ 6,425
%	- 18.3	- 11	- 0.3	+ 22.2	+ 18.8	+ 9.2	+ 7.9	+ 7.9	+ 8.3	+ 6.2
Master's F.T. Enrollments										
Change/Yr.										
No.	- 811	+ 472	- 289	- 589	+ 4,005	- 488	+ 1,360	- 816	+ 1,863	+ 1,947
%	- 3.5	+ 2.1	- 1.3	- 2.6	+ 18.2	- 1.9	+ 5.3	- 3.0	+ 7.1	+ 7.0
Doctoral F.T. Enrollments										
Change/Yr.										
No.	- 702	- 640	- 1,556	- 1,276	+ 653	- 318	+ 1,396	- 38	+ 1,140	+ 1,004
%	- 4.7	- 4.5	- 11.6	- 10.7	+ 6.1	- 2.8	+ 12.7	- 0.3	+ 9.3	+ 7.5

Data Source: Engineering Manpower Commission

total for these, but it is easy to see that they, too, did not increase at a rate to match the undergraduates' (16.3 percent).

The EMC gives the total fall 1980 undergraduate enrollment in New York engineering programs, full-time and part-time, as 27,316. Table 41 shows the ten highest states in full-time undergraduate engineering enrollments, 1976-1980. These figures do not include enrollments in two-year pre-engineering programs or five-year combined-major interinstitutional arrangements where, for example, a student may receive both a B.S. in physical science from a liberal-arts college and a B.S. in engineering from an engineering school. Actual enrollments of all students working toward eventual engineering degrees are thus undoubtedly larger than Table 39 (page 79) would indicate. In New York and nationally, the EMC figures show that engineering enrollments continued to rise between 1979 and 1980, but at a slower rate than they had in the previous year; freshman enrollments rose less than overall enrollments:

	Percentage rise in enrollments 1979-1980	Percentage rise in enrollments 1978-1979	Average percentage rise over last 5 years	Total percent rise over past 5 years
NYS	6.0%	10.9%	7.5%	33.6%
U.S.-all	7.2%	9.4%	9.1%	41.6%
U.S.-freshmen	6.2%	8.3%	7.9%	46.2%

Whether this indicates a leveling-off trend in engineering enrollments remains to be seen.

At New York engineering schools, the State Education Department survey showed that student demand to enroll in engineering programs (measured by numbers of applications) increased between 1979-1980 and 1981-1982 by 21 percent at sixteen of the 22 institutions responding to the survey (Table 42). Numbers enrolled for the first time, however, increased by an average of 5 percent. If this is the pattern nationwide, the slower growth in numbers of freshmen enrolled in engineering represents limitations placed on enrollment by the colleges in response to pressures on faculty and equipment capacity (see "Engineering Education: 'Crisis,'" below).

TABLE 41

The Top Ten States in Full-time Undergraduate Engineering Enrollment, 1976-1980

	Fall 1976			Fall 1977			Fall 1978			Fall 1979			Fall 1980		
State	Number	Rank	% of U.S. Total	Number	Rank	% of U.S. Total	Number	Rank	% of U.S. Total	Number	Rank	% of U.S. Total	Number	Rank	% of U.S. Total
California	20,711	1	8.0	23,070	1	8.0	26,315	1	8.5	29,398	1	8.6	30,535	1	8.4
New York	19,267	2	7.5	20,371	3	7.0	21,879	2	7.0	24,273	2	7.1	25,738	2	7.0
Texas	17,560	3	6.8	20,491	2	7.1	20,977	3	6.7	22,833	3	6.7	24,886	3	6.8
Pennsylvania	15,744	4	6.1	17,329	4	6.0	18,760	4	6.0	20,103	4	5.9	21,280	4	5.8
Michigan	14,680	5	5.7	16,424	5	5.7	17,207	5	5.5	19,079	5	5.6	20,370	5	5.6
Ohio	12,529	6	4.9	13,583	6	4.7	14,382	6	4.6	15,852	6	4.7	18,181	6	5.0
Massachusetts	11,545	7	4.5	12,828	7	4.4	14,353	7	4.6	15,829	7	4.6	17,072	7	4.7
Illinois	10,523	8	4.1	11,218	8	3.9	12,088	8	3.9	13,420	8	3.9	14,198	8	3.9
Indiana	9,834	9	3.8	10,321	9	3.6	10,458	9	3.4	11,645	9	3.4	11,436	9	3.1
Louisiana				6,906	10	2.4	7,712	10	2.5	7,767	10	2.3	9,359	10	2.6
Colorado	6,113	10	2.4												

Source: NYSED, Bureau of Postsecondary Planning, 1982

Table 42

Institutions Responding to Education Department Survey

April 1982

Engineering Colleges

SUNY — 6 of 6: 100%

SUNY at Buffalo
SUNY at Stony Brook
New York State College of Agriculture and Life Sciences
New York State College of Ceramics
New York State College of Environmental Science and Forestry
SUNY Maritime College

CUNY — 2 of 3: 66.7%

The City College
The Graduate Center

Independent — 14 of 14: 100%

Clarkson
Columbia
Cooper Union
Cornell
Hofstra
Manhattan College
Polytechnic Institute of New York
Pratt Institute
Rensselaer Polytechnic Institute
Rochester Institute of Technology
Syracuse University
Union College
University of Rochester
Webb Institute of Naval Architecture

TOTAL — 22 of 23: 95.7%

Colleges Offering the Bachelor of Technology Degree

6 of 6: 100%

SUNY at Binghamton
SUC at Buffalo
New York State College of Technology at Utica/Rome
CUNY: The City College
New York Institute of Technology
Rochester Institute of Technology

2. Regional Enrollments

The Department collected enrollment data from postsecondary institutions by program in 1975, 1976, 1979, and 1980 for upper-division undergraduates and for graduate students (master's and doctoral levels separately in 1979 and 1980). Table 43 shows percentages of engineering students by region in these years. Different patterns may be seen in changes at the undergraduate and graduate levels. Enrollment of upper-division undergraduates held approximately steady as a percentage of the State's engineering enrollments in the Western and Northeast Regions, fell somewhat in the Genesee Valley, Central, and New York City Regions, and rose in the Northern and Long Island Regions. Graduate enrollment remained relatively unchanged as a percentage of the New York total in the Western and Genesee Valley Regions, fell in New York City, rose slightly in the Northern Region, and more steeply in the Central, Northeast, and Long Island Regions. Statewide, undergraduate enrollments show the familiar steady rise; graduate enrollments fell from 1975 to 1979 and rose again in 1980.

3. Enrollment of Women and Minorities

Tables 44 and 45 present enrollments of undergraduate minorities and women in the U.S. and New York State from the fall of 1976 to the fall of 1980, as reported to the Engineering Manpower Commission. As with degrees (Tables 35 and 36, pages 71 and 72), women show the largest rise as a percent of total undergraduate enrollments, in the State and nationally. Numbers of blacks and Hispanics have also increased, but are still small as percentages of the total. All told, women and members of minority groups represented over 21 percent of U.S. undergraduate engineering enrollments (22 percent in New York in 1980), up from 14.5 percent (13.8 percent) in 1976.

The engineering schools responding to the Department survey could not always furnish information on female and minority applications and enrollments. In the twelve schools* giving information for women, the number of freshman women enrolled increased by 21.9 percent between 1979 and 1981, while the total number of first-time students enrolled

*SUNY at Stony Brook, NYS College of Ceramics, SUNY Maritime, Clarkson, Columbia, Cornell, Hofstra, Manhattan, Rensselaer Polytechnic Institute, Syracuse, University of Rochester, Webb Institute.

Table 43

New York State: Percentage of Total Engineering Degree-Credit Enrollments in Each Regents Postsecondary Education Region 1975, 1976, 1979, and 1980

Region:	1 Western	2 Genesee Valley	3 Central	4 Northern	5 Northeast	6* Mid-Hudson	7 New York	8 Long Island	State Total
Year									
1975									
Upper division	12.8%	8.2%	18.1%	8.0%	14.0%	0	35.1%	3.7%	8,956
Graduate	8.1%	5.4%	15.1%	1.8%	11.1%	0	52.0%	6.5%	5,805
1976									
Upper division	12.6%	7.6%	16.1%	9.9%	14.6%	0	35.4%	3.8%	9,643
Graduate	8.3%	5.5%	14.9%	2.3%	11.1%	0	47.7%	10.1%	5,215
1979									
Upper division	13.1%	6.4%	16.6%	9.2%	15.4%	0	33.3%	6.0%**	11,660
Master's	5.7%	5.2%	16.1%	3.0%	19.4%	0	49.4%	1.3%	3,479
Doctoral	13.3%	6.4%	25.3%	1.9%	15.5%	0	21.1%	16.5%	1,528
All Graduate	8.0%	5.6%	18.9%	2.7%	18.2%	0	40.7%	5.9%	5,007
1980									
Upper division	12.6%	6.8%	15.7%	9.5%	14.4%	0	32.1%	8.9%**	12,025
Master's	7.4%	5.7%	16.5%	2.4%	19.2%	2.2%	42.3%	4.4%	3,829
Doctoral	10.6%	6.3%	23.3%	2.3%	17.6%	0.4%	24.2%	15.4%	1,599
All Graduate	8.3%	5.9%	18.5%	2.4%	18.7%	1.7%	37.0%	7.6%	5,428

*Syracuse University enrolled graduate students each year at branch campuses in Regions 5 and 6. HEDS data show all as if enrolled in Region 3, site of the main campus.

**Enrollment at all branches of Polytechnic Institute of New York counted as Region 7 in 1975, 1976, and 1979, distributed among Regions 6, 7, and 8 in 1980.

Source: NYSED Postsecondary Information Systems/HEDS

Table 44

U.S. Full-time Undergraduate Engineering Enrollments Fall 1976-Fall 1980
Women and Members of Minority Groups

Group	Fall 1976 No.	Fall 1976 % of Total	Fall 1977 No.	Fall 1977 % of Total	Fall 1978 No.	Fall 1978 % of Total	Fall 1979 No.	Fall 1979 % of Total	Fall 1980 No.	Fall 1980 % of Total	Change over 5 years	Change over 5 years
Blacks	9,828	3.8%	11,388	3.9%	12,954	4.2%	14,786	4.3%	16,181	4.4%	+6,353	+64.6%
Hispanics	5,138	2.0%	8,495	2.9%	9,831	3.2%	11,127	3.3%	11,860	3.2%	+6,722	+130.8%
Amer. Indian	446	0.2%	618	0.2%	625	0.2%	759	0.2%	903	0.2%	+457	+102.5%
All Minorities	15,412	6.0%	20,501	7.1%	23,410	7.5%	26,672	7.8%	28,944	7.9%	+13,532	+87.8%
Women	21,936	8.5%	27,773	9.9%	34,518	11.1%	42,029	12.3%	48,944	13.4%	+27,008	+123.1%
U.S. Totals	257,835		289,248		311,237		340,488		365,117		+107,282	+41.6%
Percent change in U.S. Total enrollment year to year			+12.2%		+7.6%		+9.4%		+7.2%			

*Figures given for minority and female enrollments in EMC publications prior to 1976 do not represent national totals.

Source: Engineering Manpower Commission

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Table 45

New York State Full-time Undergraduate Engineering Enrollments Fall 1976-Fall 1980
Women and Members of Minority Groups

Group	Fall 1976 No.	Fall 1976 % of Total	Fall 1977 No.	Fall 1977 % of Total	Fall 1978 No.	Fall 1978 % of Total	Fall 1979 No.	Fall 1979 % of Total	Fall 1980 No.	Fall 1980 % of Total	Change over 5 years	Change over 5 years
Blacks	868	4.5%	740	3.6%	1,190	5.4%	1,328	5.5%	1,442	5.6%	+574	+66.1%
Hispanics	374	1.9%	407	2.0%	760	3.5%	942	3.9%	1,098	4.3%	+724	+194.0%
Amer. Indian	22	0.1%	28	0.1%	14	0.1%	21	0.1%	27	0.1%	+5	+22.7%
All Minorities	1,264	6.6%	1,175	5.8%	1,964	9.0%	2,291	9.4%	2,567	10.0%	+1,303	+103.1%
Women	1,378	7.2%	1,813	8.9%	2.220	10.1%	2,676	11.0%	3,114	12.1%	+1,736	+126.0%
NYS Totals	19,267		20,371		21,879		24,273		25,738		+6,471	+33.6%
Percent NYS of US Total	7.5%		7.0%		7.0%		7.1%		7.0%			avg. 7.5%/yr.

*Figures given for minority and female enrollments in EMC publications prior to 1976 do not represent state totals.

Source: Engineering Manpower Commission

increased by 3.4 percent. In 1979, women were 15.7 percent of the freshmen enrolled; in 1981, 19.8 percent. This is a considerably higher proportion than the national average. (In 1979 the EMC reported 14,031 full-time freshman women enrolled in U.S. engineering programs, 13.5 percent of the total of 103,724 full-time freshmen; in 1980 16,004 women were reported, or 14.5 percent of the 110,149 total.) Only seven schools* could give information on the Education Department survey about minorities enrolled over the past three years. One of these, SUNY at Stony Brook, changed its acceptance policy for engineering programs in fall 1981, rendering the data incompatible for that year. In 1980, these institutions enrolled nearly 11 percent more minority students in engineering programs than they had in 1979; in the absence of more complete data, it is impossible to draw further conclusions. (EMC reports show 10,424 students from the three minority groups enrolled in the U.S. in 1979, or 10.0 percent of all freshmen; in 1980 the number was 11,234, or 10.2 percent.)

4. Access to Engineering Education in New York State

The question of access has several facets. Geographic access is one: does sheer distance limit access of students to engineering education in some areas of the State? Access for previously underrepresented groups has been discussed above. Finally, access depends to a large extent upon the circumstances of one's life: full-time employment, level of program desired, family ties, quality of elementary and secondary preparation, and financial resources all affect one's opportunities to enroll as an engineering student.

Geographic limitations on access are difficult to assess. Students' choices of institutions depend not only upon location, but upon such other factors as the nature of the

*SUNY at Stony Brook, NYS College of Ceramics, CUNY City College, Clarkson, Rensselaer Polytechnic Institute, Syracuse, and the University of Rochester.

programs offered, the size and type of the college, and what may be called its character as perceived by the student. Keeping in mind that these factors also influence student decisions, one indicator of a college's accessibility is the origin of its present student body. Through the Higher Education Data System (HEDS) the Department has residence and migration data for 1975, 1977, and 1979 showing the numbers of students attending New York postsecondary institutions from each county of the State and from out-of-state. From these records it is possible to ascertain, for each institution which offers engineering or technology programs, (1) what percentage of its students came in those years from its own and adjoining counties, (2) what percentage came from out-of-state, (3) what percentage were from foreign countries, and (4) what New York counties were represented in its student body as a whole. (Separate figures for different fields of study are not available.)

Due to the sheer bulk of data, the figures reported in this section are drawn from a selection of engineering institutions and not from the complete set.* (All the B. Tech. institutions are included.) The list was selected to represent a substantial portion of each sector and to include most of the largest institutions, on the principle that they enrolled the bulk of the students in each sector. Although an exhaustive analysis would undoubtedly change somewhat the results reported here, they may be taken as representative of residence and migration at New York's colleges which offer engineering programs.

For 1979, the most recent year for which data are available, Table 46 shows the percentage of full-time undergraduates at each institution who came (1) from the county in which the institution is located and adjoining counties, (2) from out-of-state, (3) from foreign countries, and (4) from elsewhere in New York State. Table 47 gives the same information for full-time and part-time graduate students, since (unlike undergraduates) a substantial portion of graduate students in engineering attend part-time. (In both cases, the

*The institutions examined are SUNY at Binghamton, SUNY at Buffalo, SUNY at Stony Brook, SUNY College of Technology at Utica/Rome, the State University College at Buffalo, New York State College of Agriculture and Life Sciences, CUNY City College, CUNY Graduate Center, Clarkson, Cornell, Hofstra, New York Institute of Technology, Polytechnic Institute of New York, Rensselaer Polytechnic Institute, Rochester Institute of Technology, Syracuse, and the University of Rochester.

Table 46

Geographic Origins of Full-time Undergraduates at Selected Institutions Offering Engineering and Technology Programs
1979

Engineering Colleges:

Institution	Percent of Students from: Same and Adjoining Counties	Out of State	Foreign Countries	Other NYS
SUNY at Buffalo	53	1	3	43
SUNY at Stony Brook	61	2	3	34
NYS Col. of Agriculture	10	17	2	71
Average	41	7	3	49
CUNY City College	92	0	1	7
Clarkson	12	14	1	73
Cornell	5	58	4	33
Hofstra	88	7	1	4
P.I.N.Y.	65	2	11	22
R.P.I.	7	51	3	39
R.I.T.	31	17	1	51
Syracuse	17	39	4	40
Univ. of Rochester	15	41	1	43
Average	30	29	3	38
Grand Average	38	21	3	38

Bachelor of Technology Degree:

SUNY at Binghamton	16	2	1	81
NYS Col. of Technology	45	1	0	54
State Col. at Buffalo	68	1	2	29
Average	43	0	1	56
CUNY City College	92	0	1	7
NY Inst. of Technology				
Metropolitan Center	40	4	47	9
Old Westbury	62	5	7	26
R.I.T.	31	17	1	51
Average	45	9	18	28
Grand Average	50	4	8	38

Source: NYSED Postsecondary Information Systems/HEDS

Table 47

Geographic Origins of Graduate Students at Selected Institutions
Offering Graduate Degrees in Engineering
1979

Institution	Full-Time Percent of Students From: Same and Adjoining Counties	Out of State	Foreign Countries	Other NYS	Part-Time Percent of Students From: Same and Adjoining Counties	Out of State	Foreign Countries	Other NYS
SUNY at Buffalo	51	6	22	21	68	5	8	19
SUNY at Stony Brook	39	19	26	16	91	2	2	5
NYSC of Agriculture	24	41	22	13	-	-	-	-
Average	38	22	23	17	80	4	5	12
CUNY Graduate Center	75	3	11	6	83	9	5	3
Clarkson	29	10	29	32	69	4	12	15
Cornell	17	57	10	16	67	17	6	10
P.I.N.Y.	43	5	47	5	51	13	0	36
R.P.I.	17	31	20	32	28	44	0	28
R.I.T.	50	28	6	16	96	0	1	3
Syracuse	43	16	19	22	58	5	6	31
Univ. of Rochester	21	47	15	17	72	17	1	10
Average	31	28	21	20	63	14	6	19
Grand Average	37	24	21	18	68	12	4	16

Source: NYSED Postsecondary Information Systems/HEDS

numbers for 1975 and 1977 were quite consistent with those for 1979.) In both tables, the last column is the significant one for geographic access of in-state students, since it shows the percentages of students who attended these institutions from other parts of the State. No clear overall picture emerges from an analysis of these disparate figures, however, except that for both full-time undergraduate and graduate students institutions in New York City and on Long Island (Polytechnic Institute of New York, City College, Hofstra, and SUNY at Stony Brook) had relatively low percentages from other areas of the State. It will be noted that the proportion of out-of-state students is less than 20 percent at all institutions offering the Bachelor of Technology degree; that the same is true for undergraduates at all the colleges with engineering programs except for Cornell, Rensselaer Polytechnic Institute, Syracuse University, and the University of Rochester; and that institutions offering graduate degrees in engineering enroll significant proportions of both out-of-state and foreign students.

A better idea of New York students' access to colleges offering engineering and B. Tech. degrees can perhaps be obtained by examining the lists of institutions actually attended by undergraduates from selected counties across the State where there is no engineering institution (Table 48). No counties in the New York City or Long Island regions are shown, because their residents attend virtually every institution in the State (although they concentrate, as might be expected, in their own regions). Ten counties were selected; eight either were relatively populous or were designated as part of a major labor market area by the State Department of Labor. All but Albany County are located around the margins of the State.

It is immediately obvious from Table 48 that students from all these counties attend most of the engineering and B. Tech. colleges in the State. From Tioga County, the least populous (ranking 48th of New York's 62 counties in population, according to the 1980 U.S. Census), students went to fifteen engineering institutions and five of the six B. Tech. institutions as undergraduates (ten or more went to ten of them). From Clinton County,

TABLE 48

Attendance at Engineering and Technology Institutions
from Selected Counties, New York 1979

Undergraduates

County	1980 Population		Distance from an Engineering School*	Number of institutions attended		Institutions attended by significant numbers	Most attended institutions
	Number	Rank among NY counties		Eng.	B.Tech.		
Albany	285,909	12	Relatively near	20	6 (all)	SUNY Binghamton SUNY Buffalo SUC Buffalo NYSC Env. NYSC Ag. Clarkson Cornell	R.P.I. Syracuse Union
Broome	213,648	18	Relatively far	19	4	Syracuse R.I.T. SUNY Buffalo	SUNY Binghamton
Chautauqua	146,925	23	Relatively far	18	5	SUNY Binghamton NYSC Env. NYSC Ag. NYSC Ceramics Clarkson Cornell R.I.T. U. of Rochester	SUNY Buffalo SUC Buffalo
Chemung	97,656	27	Relatively far	17	5	SUNY Binghamton SUC Buffalo NYSC Ag. NYSC Env. NYSC Ceramics SUNY Tech. Clarkson Cornell R.P.I. U. of Rochester	SUNY Buffalo R.I.T. Syracuse

*See Figure 2.

TABLE 48 cont.

County	1980 Population		Distance from an Engineering School*	Number of institutions attended		Institutions attended by significant numbers	Most attended institutions
	Number	Rank among NY counties		Eng.	B.Tech.		
Clinton	80,750	33	Far	17	4	SUNY Buffalo	Clarkson
Dutchess	245,055	16	Relatively far	21	5	Clarkson SUNY Binghamton SUNY Stony Brook SUC Buffalo R.I.T. Union Cornell NYSC Ag.	Syracuse R.P.I. SUNY Buffalo
Niagara	227,354	17	Relatively far	19	4	SUNY Binghamton NYSC Env. NYSC Ag. Clarkson Cornell R.P.I. R.I.T. Syracuse U. of Rochester	SUNY Buffalo SUC Buffalo
Oswego	113,901	25	Relatively far	18	4	SUNY Binghamton SUNY Buffalo SUC Buffalo NYSC Env. NYSC Ag. R.I.T.	Clarkson Syracuse
Rockland	259,530	14	Relatively far	23	6	SUNY Stony Brook SUC Buffalo Columbia NYSC Ag. Cornell R.P.I.	SUNY Binghamton SUNY Buffalo Manhattan Syracuse
Tioga	49,812	48	Relatively far	15	5	R.I.T. Syracuse Clarkson Cornell	SUNY Binghamton

Source: NYSED, Bureau of Postsecondary Planning, 1982

geographically one of the most remote from an engineering college, students attended fifteen engineering and four B. Tech. colleges (ten or more attended six of the institutions).

Full-time undergraduate students can reside on campus; for them access is not the problem it is for part-time students -- particularly for employed persons. The question of access is most crucial for those who are employed as technicians or engineers and wish to continue their education, either to pursue a higher degree or to keep their skills current. Because technical knowledge so rapidly becomes outdated, it is a common pattern for a practicing engineer to continue study at the graduate level on a part-time basis while working full-time. Generally, such study culminates in a master's degree in an engineering discipline.

In May 1981, a study of industry and engineering employment in the Binghamton area was conducted by the National Center for Higher Education Management Systems (NCHEMS) of Boulder, Colorado, for the State University of New York. As part of the study, NCHEMS personnel interviewed senior officers at fourteen major companies in the area. A survey seeking employers' views of their workers' educational needs was returned to NCHEMS by ten of the fourteen companies; together, these ten employed about 87 percent of those who worked in high-technology industry. As a result of this research, the study concluded that industry in the area would find it less difficult to hire technical personnel if there were more opportunities in the area for further education for engineers and technicians.[41] The off-campus programs offered in the area by Syracuse University were considered helpful, but insufficient due to the effects of other demands on Syracuse faculty and the difficulty of assuring effective student advising.[42] In such an area, where there is a concentration of high-technology industry but no engineering school to afford engineers the opportunity to study, the question of access is most crucial.

Enrollment and Degree Projections

The table on page 81 shows that since 1976, New York's undergraduate engineering enrollments have risen, although not quite so steeply as those in the nation as a whole. Does this mean that the State's production of baccalaureate engineers, which had been rising at a

lower rate than the nation's (Table 19, page 50), will continue to do so in the early 1980's? (According to the EMC, only .2 percent more bachelor's degrees were awarded in New York in 1981 than in 1980 [Table 20, page 53].) This line of reasoning from enrollments to degrees, for example, led Harrison Shull, former Provost at Rensselaer Polytechnic Institute, to reason that the record high of 110,000 engineering freshmen in 1980 would generate 75,000 entrants into the job market in 1984 (given Shull's estimate of a historical graduation rate of over 70 percent) -- causing "a modest surplus in supply."[43] The "70 percent graduation rate" for freshmen, however, is of fairly recent vintage. From 1957 through 1974, bachelor's degrees in engineering averaged 53 percent of freshmen four years earlier (ranging from 45.5 percent in 1961 to 58.6 percent in 1973). Between 1975 and 1977 they leaped to 73 percent, averaging 71.3 percent between 1975 and 1981 (Table 49).

Table 49 illustrates the fact that the engineering fields show "repeated oscillation between 'shortages' and 'surpluses'" of manpower supply due to students' perception of job-market opportunities.[44] In 1971, Richard B. Freeman presented a "Cobweb Model" for forecasting engineering manpower supply. Freeman's analysis of figures from 1947 through 1967 showed that "changes in the fraction of freshmen [males] in engineering are closely related to changes in engineering starting salaries" (Figure 12).[45] As the latter rise, more freshmen enter college intending to study engineering; when the resulting graduates entering the labor market exceed the number of openings, starting salaries fall and, perceiving this, fewer freshmen enter college to study engineering. But such factors affect attrition as well; Table 50 shows that the number of full-time juniors has also fluctuated since 1967, although not as widely as the number of freshmen. Juniors as a percent of freshmen enrolled two years previously were around 64 percent from 1967 through 1972, rose to 95 percent between 1973 and 1975, then declined again to around 84 percent. Between 1969 and 1980, bachelor's degrees as a percent of juniors two years previously averaged 86.1 percent, ranging from 79.2 percent in 1969 to 91.7 percent in 1975. Attrition reduces the number enrolled from year to year; the attractiveness of engineering as a profession causes students from other majors to switch to engineering, increasing the number enrolled. Thus, no reliable projections can be made on this basis.

TABLE 49

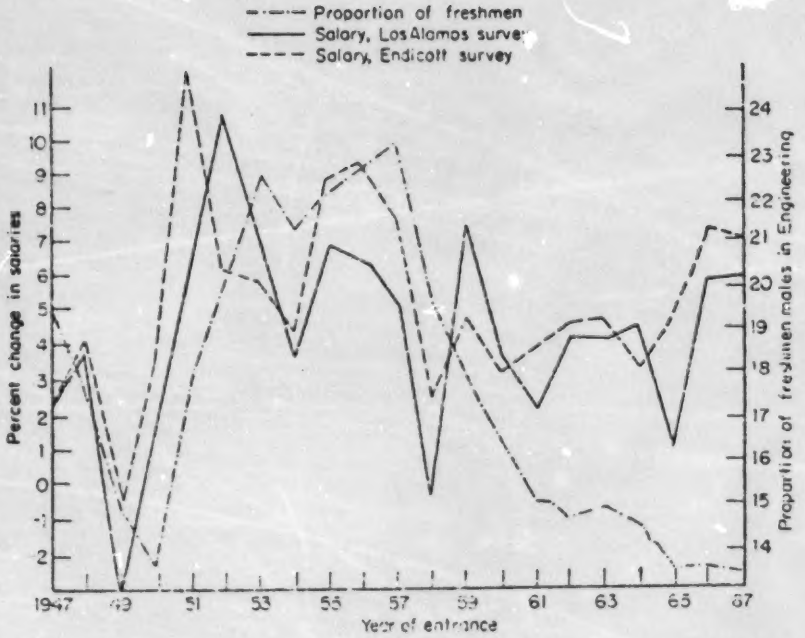
Bachelor's Degrees in Engineering as a Percent of Full-time Freshmen Four Years Earlier (U.S.)

Year	Full-time Freshmen Enrolled (Fall)	Year	Number of Bachelor's Degrees	Degrees as a % of Freshmen
1953	60,478	1957	31,221	51.6
1954	65,505	1958	35,332	53.9
1955	72,825	1959	38,134	52.4
1956	77,738	1960	37,808	48.6
1957	78,757	1961	35,860	45.5
1958	70,029	1962	34,735	49.6
1959	67,704	1963	33,458	49.4
1960	67,556	1964	35,226	52.1
1961	67,575	1965	36,691	54.3
1962	64,707	1966	35,815	55.3
1963	65,740	1967	36,186	55.0
1964	73,682	1968	38,002	51.6
1965	79,872	1969	39,972	50.0
1966	78,400*	1970	42,966	54.8*
1967	77,551	1971	43,167	55.7
1968	77,484	1972	44,190	57.0
1969	74,113	1973	43,429	58.6
1970	71,661	1974	41,407	57.8
1971	58,566	1975	38,210	65.2
1972	52,100	1976	37,970	72.9
1973	51,925	1977	40,095	77.2
1974	63,444	1978	46,091	72.6
1975	75,343	1979	52,598	69.8
1976	82,250	1980	58,117	70.7
1977	88,780	1981	62,935	70.8

Source: EMC, Placement of Engineering and Technology Graduates 1980 and Engineering and Technology Degrees 1980 and 1981. Data through 1966 are from the United States Department of Education; 1967 to 1981, from EMC surveys.

* EMC estimate

Figure 12



4.1 Proportion of freshmen in engineering and changes in engineering salaries, 1947–1967

Source: Richard B. Freeman, The Market for College-Trained Manpower (Cambridge, Mass., 1971), p. 61.

TABLE 50

Full-time Juniors Enrolled in Engineering (U.S.) as a Percent of Full-time Freshmen Two Years Earlier; Bachelor's Degrees in Engineering as a percent of Full-time Juniors Two Years Earlier

Year	Full-time Freshmen	Full-time Juniors	Juniors as a Percent of Freshmen 2 Years Previously	Bachelor's Degrees in Engineering	Bachelor's Degrees as a Percent of Juniors 2 Years Previously
1965	79,872				
1966	78,400*			36,186	
1967	77,551	50,483	63.2	38,002	
1968	77,484	50,274	64.1	39,972	79.2
1969	74,113	50,039	64.5	42,966	85.5
1970	71,661	49,855	64.3	43,167	86.3
1971	58,566	48,543	65.5	44,190	88.6
1972	52,100	45,874	64.0	43,429	89.5
1973	51,925	41,673	71.2	41,407	90.3
1974	63,444	43,007	82.5	38,210	91.7
1975	75,343	49,338	95.0	37,970	88.3
1976	82,250	56,835	89.6	40,095	81.3
1977	88,780	64,721	85.9	46,091	81.1
1978	95,805	69,816	84.9	52,598	81.3
1979	103,724	74,928	84.4	58,117	89.8
1980	110,149	80,024	83.5		

*Number of full-time freshmen estimated for 1966 by EMC.

Source: Engineering Manpower Commission

If enrollments are an uncertain predictor of degrees granted, how reliable are demographics as a predictor of future enrollments? Nationwide, the proportion of 15-to-24-year-olds (those of traditional college age) is projected to drop between 1980 and 1990—in New York, the projected decline is 12.6 percent (see Table 51). The 1990 population projections given there were made on the basis of earlier census data than the ones shown in the first column of the same table. When the Department revises its 1990 population projections using the new census data, the percentage of 15-to-24-year-olds will probably decline more sharply. It should be noted that, by contrast, the college-age population was rising for the period of enrollments examined earlier in this report (the 1970's). To look at a related consideration, according to August 1981 Department projections, the number of high-school graduates in New York will decline 31 percent between 1980 and 1990 (Table 51). From 1975 through 1980, Department figures show that the proportion of New York's high-school graduates entering degree-granting institutions as full-time students the following year increased slightly, although probably not significantly (from around 47 percent to nearly 49 percent). Taking such factors into consideration, total postsecondary enrollments are projected to decline through the 1980's. As Figure 11 (page 77) shows, engineering's share of enrollments has been rising steeply. Even if this trend were to continue, engineering enrollments must be affected, along with all others, by the decline in the college-age population. Increasing participation of women and minorities will probably compensate for some of this decline, as we have seen. Betty M. Vetter has tracked women's entry into engineering for the Scientific Manpower Commission; from the EMC's series of publications on enrollments, she found that the number of women enrolled in engineering at all levels had increased from 3,569 in 1969 to almost 49,000 in 1980 (1,271 percent), while men's enrollments were up by 38.6 percent. By 1980, women made up 13.4 percent of all full-time undergraduates in engineering and received 10.4 percent of the bachelor's degrees, whereas in 1970 they had been 1.5 percent of those enrolled full-time and had received 0.8 percent of the baccalaureates.[46] The picture for New York is similar, as we have seen.

Table 51

Summary of Major Population Trends and Projected College Enrollment
New York State
1979-80 to 1990-91

Pop. by Age*	1980 Historical Male	1980 Historical Female	1980 Historical Total	1990 Projected Male	1990 Projected Female	1990 Projected Total	Percent Change Male	Percent Change Female	Percent Change Total
15-19	808,383	794,869	1,598,252	642,151	617,553	1,259,704	-20	-22	-21
20-24	737,565	782,399	1,519,964	737,617	728,347	1,465,964	0	-7	-4
25-34	1,340,499	1,439,812	2,780,311	1,745,237	1,674,562	3,419,799	+30	+16	+23
35-44	972,906	1,070,175	2,043,081	1,393,306	1,449,915	2,843,221	+43	+35	+39
45-59	1,358,281	1,529,005	2,887,286	1,276,198	1,469,162	2,745,360	-6	-4	-5

High School Graduates	1980 Historical	1990 Projected	Percent Change
New York State	235,937	162,233	-31
Regions-Western	24,670	16,411	-33
Genesee Valley	19,755	13,900	-30
Central	20,005	13,491	-33
Northern	4,667	3,166	-32
Northeast	23,075	16,602	-28
Mid-Hudson	30,345	19,660	-35
New York City	65,490	48,815	-25
Long Island	48,028	30,190	-37

College Enrollments	1980 Preliminary	1990 Projected	Percent Change
Full-Time Undergraduate	560,223	420,200	-25
Part-Time Undergraduate	243,277	231,600	-5
Full-Time Graduate	46,682	44,200	-5
Part-Time Graduate	98,007	100,250	+2
Total First-Professional	23,943	23,950	0

Source: NYSED, Postsecondary Research and Information Systems, 1982 (C.D. Jan. 82)
*Source: U.S. Bureau of the Census

Women are on the increase, too, in graduate study: the annual increase in their numbers (as full-time students in departments granting doctoral degrees) was 9 percent between 1974 and 1979, while the number of men increased 0.4 percent annually. According to the National Center for Education Statistics, women received 6.1 percent of master's degrees and 2.5 percent of doctorates in engineering in 1979 (1.1 percent and 0.4 percent in 1970) and 3.6 percent of 1980 doctorates.[47]

Increasing enrollments for underrepresented minority groups have been noted earlier (Tables 44 and 45, pages 86 and 87), but degrees granted to members of these groups have not increased as much (Tables 35 and 36, pages 71 and 72). Programs have been established to aid minority students financially and academically; for example, the National Action Council for Minorities in Engineering, Inc., sponsors several programs (including incentive grants for schools to distribute to minority students, aid for minority retention efforts, and the like). If proposed cuts in Federal loan programs are enacted, dependence of minority students on financial assistance could reduce their participation in coming years.

The National Center for Education Statistics and the Scientific Manpower Commission both issue projections of engineering degrees (see Table 12, page 30). In the near future, the American Association of Engineering Societies (AAES) will attempt to develop a model to predict annually the number of degrees to be awarded in engineering. It remains to be seen whether the AAES will find women and minorities choosing to study engineering in sufficient numbers to offset the overall decline in the college-student pool. The EMC aims to publish the projections annually starting in 1982.

For New York State, some rough estimate of future engineering enrollments may be calculated by noting that from 1970 through 1979, ratios of engineering enrollments to total enrollments ranged as follows.*

*The Department did not collect enrollments by field of study prior to 1970.

	Upper-division undergraduate	Master's degree level	Doctoral level
lowest percentage over the period	4.6 percent	3.9 percent	5.3 percent
highest percentage	6.4 percent	6.1 percent	10.6 percent

Applying these proportions to the Department's enrollment projections, one might expect engineering degree-credit enrollments for 1990 to range from approximately 8,090 to 11,200 for upper-division undergraduates, from 4,500 to 7,050 for master's degree programs, and from 1,530 to 3,060 at the doctoral level, compared to 14,359, 3,850, and 1,614 in 1980-81. These are to be taken only as very approximate indications, however, for in the case of undergraduates, the Department projects only a total figure, whereas the historical enrollment figures are for upper-division students only. Since upper-division undergraduates from 1970 through 1979 averaged 27 percent of the total, that proportion was used to estimate for 1981-1990. Likewise, the projections give a combined figure for graduate students; these were estimated using an 80 percent master's, 20 percent doctorate approximation derived from historical figures.

Fifteen engineering schools projected enrollments for 1984 on the Department survey. Based on their response, it may reasonably be projected that full-time undergraduate engineering enrollment in existing programs will rise from a combined total of 26,944 students in 1981 to 27,616 in 1984, or 2.5 percent. This slight increase was distributed approximately evenly (proportionally speaking) between the State University and the independent sector. Engineering enrollments were expected to go up at four of the six SUNY campuses surveyed, and at four of the nine independent institutions responding to this item on the questionnaire. By contrast, all fifteen institutions projected stable or increasing enrollments at the master's and doctoral levels; and four out of five schools offering Bachelor of Technology programs projected that enrollments in those programs would increase by 27.7 percent. In sum, the institutions' own projections for undergraduates are

higher than the rough estimate given above (even accounting for the fact that the estimate is for upper-division students only). The schools project that undergraduate engineering enrollment will hold steady, citing in their remarks such factors as continuing demand for engineers in the economy, the attractiveness of engineering as a major, and the increasing enrollment of women. In view of the decline in the college-age population, this seems to imply that engineering enrollment will be an increasing fraction of total enrollments.

Engineering Education: "Crisis"

Faculty

Figures 8 and 11 (pages 48 and 77, respectively) reveal a nationwide pattern reflected in New York engineering degrees and enrollments: in recent years, as the numbers enrolled in undergraduate programs have been increasing sharply, enrollments and degrees at the doctoral level have barely held steady. Assuming that most new recruitment for engineering faculties must come from the ranks of recent doctorates, the engineering schools' dilemma is obvious. It becomes even more serious in the light of the EMC's report that over one-third of the 1980 doctorates from U.S. engineering schools (982 out of 2,753) went to foreign nationals. However, some of these remain in this country; a special report by the NSF found that almost one-fourth of engineering instructors and assistant professors in the U.S. in the fall of 1980 had earned their bachelor's degrees in another country.[48]

Nevertheless, the supply is insufficient. A spring 1980 survey by the American Institute of Chemical Engineers reported 172 full-time, tenure-track positions currently unfilled--13 percent of total full-time positions--in 83 of the 120 responding departments of chemical engineering.[49] This picture is typical, according to the NSF report as summarized in a November issue of The Chronicle of Higher Education: across the board in the fall of 1980, 11 percent of the 16,200 positions in engineering departments at U.S. colleges and universities were vacant (rates in the various fields ranged from 4 percent for aeronautical/

astronautical to 16 percent in computer engineering.)[50] The American Council on Education also surveyed the faculty shortage in U.S. engineering schools in the fall of 1980. In the fall of 1981, the New York State Assembly Task Force on University-Industry Cooperation used a modified version of the A.C.E. survey to inquire about the rate of unfilled positions on New York's engineering facilities. With eighteen out of twenty-three engineering schools responding, the Task Force found that 7.7 percent of budgeted faculty positions were unfilled as of that autumn; 55.1 percent of these had been vacant for one year.

All but one of the engineering schools which responded to the Department survey furnished figures relating to faculty vacancies. (Results from the Bachelor of Technology schools were inconclusive.) The schools reported the following numbers of vacant faculty positions:

Year	Total no. of full-time faculty	No. of vacant positions reported	Percent of positions vacant
1979-80	1,289	62	4.8%
1980-81	1,321	82	6.2%
1981-82	1,360	92	6.8%

Most vacancies were reported at the rank of assistant professor (nearly twice as many as professor and associate professor combined). Mechanical engineering, chemical engineering, electrical and computer engineering, and industrial engineering were mentioned most often as the most difficult fields in which to recruit new faculty members. The colleges were also asked to report the numbers of foreign nationals employed on their faculties. At eighteen responding colleges, an average of 12.6 percent of full-time faculty members were foreign nationals in the past five years (the figure was 14.7 percent in 1981-82).

Schools were also asked whether engineering faculty were being used below, at, or above capacity. Two engineering colleges reported faculty being used below capacity, ten at capacity (eight for three or more years), and ten above capacity (seven for three or more years). Of the B. Tech. institutions, four reported faculty used at capacity (two for three or more years) and one above capacity (for three years).

Not only are engineering doctorates declining in number; the proportion who enter academia is also decreasing. A 1979 report on the same subject by the NSF stated that in 1978, 24 percent of the total full-time faculty in "sixteen representative S/E [science and engineering] fields" consisted of recent doctorates*--down from 28 percent in 1975, and 42 percent in 1968. Between 1968 and 1978, while total full-time faculty with doctoral degrees increased by 14 percent, the number of recent doctorates among them decreased 39 percent. The situation is as bad in engineering as in other scientific fields; according to the NSF, the proportion of recent doctorates in electrical engineering, for example, had decreased "by one-fifth or more."[51] The National Research Council, in its 1978 report A Century of Doctorates, included the following information:[52]

Percentage of engineering doctorate recipients entering employment who took academic jobs:

Year:	1960-64	1965-68	1969-70	1971-72	1973-74
Men:	39.7	34.3	32.6	32.0	25.6
Women:	31.0	24.1	54.2	54.5	53.6
TOTAL:	39.7	34.2	32.7	32.1	26.0

The total percentage was on the decline. The increasing percentages of female doctorate holders entering academia is one brighter note, but they have traditionally been few in actual number. (In 1980, women earned 88 [3 percent] of the 2,753 doctorates in engineering, according to the EMC.) Although Betty M. Vetter of the Scientific Manpower Commission, noting that 22.6 percent of all 1980 doctorates in science and engineering were earned by women, projected from current enrollments that they would make up 35 to 40 percent of the total by 1989, most of these numbers to date have been in other scientific fields rather than in engineering.[53] An influx of women, therefore, seems unlikely to take up much of the slack on engineering faculties in the coming decade.

To summarize the current figures just reviewed: fewer than 1,800 U.S. citizens received doctoral engineering degrees in 1980. Around one-fourth of these (approximately

*Defined as those who had possessed the degree for up to seven years.

440) probably will enter academia. Some foreign-national doctorate recipients will elect to remain in this country, but probably not enough to make up a pool sufficient to fill the approximately 1,750 current faculty vacancies.

Indeed, in 1980, engineering departments in 64 percent of public postsecondary institutions, and 29 percent of independent institutions, responding to the NSF special survey reported greater difficulty in recruiting new faculty during the past five years than they had previously experienced. In addition, 3 percent of full-time permanent engineering faculty in all schools responding had resigned in the 1979-80 academic year to take jobs in industry. Of the engineering schools reporting difficulty in recruiting faculty, 80 percent reported that teaching loads of the remaining faculty had increased; two-thirds reported increased use of teaching assistants and part-time faculty; and 54 percent reported being unable to offer courses in certain subjects.[54] (See the following page for similar reports from New York's engineering colleges.)

The heads of the departments surveyed cited competition from industry as the reason for the shortage of candidates for faculty positions. According to a survey by The Chronicle of Higher Education, the average salary for assistant professors in engineering and computer science was $23,500 for the 1981-82 academic year, with $22,000 the low and $26,225 the high for this rank, the most common at which new Ph.D.'s are hired.[55] Yet the College Placement Council's 1981 survey showed that in many fields, a new graduate with a bachelor's degree in engineering would earn $22,500 or more. For new recipients of doctoral degrees, the EMC's 1981 salary survey showed salaries for faculty positions averaging $11,000 a year less than salaries for research and development positions in industry.[56] (This figure does not take into account supplementary income earned by faculty members.) Under these conditions, it is easy to see why fewer engineering graduates enroll in Ph.D. programs, and why those who do choose to enter industry rather than academia after receiving the doctorate.

If engineering enrollments decline with total enrollments, the faculty-student ratios would be lowered to some extent. In New York State, for example, the rough estimates for engineering degree-credit enrollments in the late 1980's (see page 103 above) are 22 to 44 percent below 1980 levels. Given continuing strong employer demand in certain fields, however, it is still possible that some faculty shortages would continue.

Facilities and Equipment

The State Education Department survey also asked whether engineering facilities were being used below, at, or above capacity. Four engineering colleges and two B. Tech. colleges reported they were used below capacity; nine engineering schools and three B. Tech. colleges at capacity (at seven of the institutions this had been the case for three or more years), and at nine engineering colleges facilities use was above capacity (seven for three or more years). Both faculty and facilities were being used at or above capacity at most institutions responding to the survey.

The institutions reported the following consequences:

Restricted transfers from other institutions: 6

Limited freshman enrollments in engineering: 8

Higher student-faculty ratios: 9

Increased attrition: 2

Other responses listed by more than one institution were lowered faculty morale and faculty "burnout."

U.S. engineering schools have also been finding it difficult to replace obsolescent laboratory equipment. Russell McGregor has termed most institutions' equipment "outdated and archaic;" he cites a 1981 estimate by George M.Low, President of Rensselaer Polytechnic Institute, that nationwide, $500 million would be required to "bring it up to an adequate standard," with $90 million needed annually after that (about $1,500 per bachelor's degree granted in 1980, by the estimate of the Accreditation Board for Engineering and Technology) to maintain equipment at that level.[57] Within New York State, a pro rata share

would be $35 million to update equipment and $7.5 million annually to maintain it at an adequate level. The Education Department survey asked engineering and B. Tech. schools to estimate the amounts needed to replace obsolescent laboratory equipment, acquire new equipment needed to support existing programs, and maintain equipment at an adequate level once laboratories were brought up to date. The seventeen engineering schools responding to this part of the questionnaire estimated that an average of 32 percent of their laboratory equipment was obsolescent or obsolete (the figures ranged from 8 percent to 80 percent).* Table 52 shows the amounts they estimated were needed to bring engineering laboratories up to date; Table 53 shows amounts budgeted for equipment replacement and acquisition in 1981-1982.

The figures furnished by the colleges indicate that they would need a total of about $58.1 million to update laboratory equipment plus $2.8 million annually to maintain it at an adequate level, and that a total of $10.9 million was budgeted for such purposes in 1981-1982. These estimates have been provided by the institutions; it is impossible at this time to judge their accuracy. If they are accurate, they indicate a major problem.

*SUNY at Buffalo, SUNY at Stony Brook, NYS College of Agriculture and Life Sciences, NYS College of Ceramics, NYS College of Environmental Science and Forestry, SUNY Maritime, CUNY City College/Graduate Center, Clarkson College of Technology, Columbia University, Cooper Union, Hofstra University, Manhattan College, Polytechnic Institute of New York, Rensselaer Polytechnic Institute, Rochester Institute of Technology, Syracuse University, and the University of Rochester.

TABLE 52

Amounts Needed To Bring Engineering Laboratory Equipment
Up to Date at 17 New York Engineering Schools

	Amount Needed	Average
SUNY		(6 institutions)
replacement	$10,221,800	$1,703,633
incremental	3,325,000	554,167
TOTAL	$13,546,800	$2,257,800
Additional needed yearly:	$ 955,000	$ 159,167
CUNY		(2 centers count as one)
replacement	$ 600,000	$ 600,000
incremental	500,000	500,000
TOTAL	$ 1,100,000	$1,100,000
Additional needed yearly:	$ 150,000	$ 150,000
INDEPENDENT		(10 institutions)
replacement	$ 7,630,000	$ 763,000
incremental	35,780,000	3,578,000
TOTAL	$43,410,000	$4,341,000
Additional needed yearly:	$ 1,670,000	$ 167,000
ALL INSTITUTIONS		(17 institutions)
replacement	$18,451,800	$1,085,400
incremental	39,605,000	2,329,706
TOTAL	$58,056,800	$3,415,106
Additional needed yearly:	$ 2,775,000	$ 163,235

Source: NYSED, Bureau of Postsecondary Planning, 1982

TABLE 53

Amounts Budgeted (All Funds) for Laboratory Equipment
at 17 New York Engineering Schools, 1981-1982

		Average (6 institutions)
SUNY		
total replacement	$ 706,992	$ 117,832
total incremental	1,090,550	181,758
TOTAL	$1,797,542	$ 299,590
CUNY		Average (2 centers count as one)
total replacement	$ 373,000	$ 373,000
total incremental	0	0
TOTAL	$ 373,000	$ 373,000
INDEPENDENT		Average (10 institutions)
total replacement	$2,401,512	$ 240,151
total incremental	6,308,762	630,876
TOTAL	$8,710,274	$ 871,027
ALL INSTITUTIONS		Average (17 institutions)
total replacement	$ 3,481,504	$ 204,794
total incremental	7,399,312	435,254
TOTAL	$10,880,816	$ 640,048

Source: NYSED, Bureau of Postsecondary Planning, 1982

Recommendations for the Development of Engineering Education in New York State

Undergraduate Programs

Recommendation 1. *The Regents recommend that New York State expand its capacity in undergraduate engineering education by 5 to 10 percent by 1985.*

Rationale: Reasons for this recommendation spring from two sources: an excess of qualified applicants and the needs of New York industry to fill engineering positions, with consequences for the State's economic development.

New York's output of baccalaureate engineers is high -- 4,000 - 5,000 new graduates annually for the past five years. However, the engineering market is a national one, and about half of the graduates take jobs outside New York State (the range among the schools responding to this question on the Department survey is 20 percent to 75 percent). High-technology industries have been pointed out as a strength which New York should build upon in its economic development efforts. Such industry needs a high concentration of engineers and technicians. In addition, there will be a far greater number of engineers reaching retirement age in the mid-to-late 1980's than in the 1970's. Based on available projections (the U.S. Bureau of Labor Statistics and the State Labor Department) it appears that there will be a modest shortage of engineers in the State throughout the 1980's, if recent levels of demand hold up. The extent of the shortage will differ among engineering fields.

Whether recent demand levels will hold, decline, or rise cannot be answered definitely on the basis of current information. We are in a recession, and there are indications which might mean some softening of the demand for engineers. However, there is no way to tell whether this is the beginning of a trend. If it is not, a modest shortage is predicted; if it is, some surplus capacity can be tolerated, and it is argued that engineering education provides a sufficiently broad background for a variety of non-engineering careers.

In some parts of the State, industry reports having greater than normal difficulty in recruiting engineers. If a modest shortage continues statewide, the industries in these areas will continue to be at a competitive disadvantage.

On the access side, applications to engineering baccalaureate programs have, in the last three years, risen steadily (an overall 21 percent at sixteen schools responding to this part of the recent Department survey). Enrollments have not risen correspondingly, because most schools report that they are at or above capacity. (At the same schools, enrollments rose only 5 percent over the past three years.) Schools responding to the survey project an overall enrollment increase of only 2.5 percent through 1984. The survey also showed 1981 freshman applications exceeding numbers enrolled by approximately a factor of four at the sixteen responding institutions. From the survey responses, about 60 percent of the total of 28,870 applications received for the 1981-82 academic year were from New York State. It can be assumed that students make multiple applications. It can also be assumed that not all applicants are academically prepared to succeed in the engineering curriculum. Consequently, the number of qualified New York State applicants who are not finding places in engineering programs is not as great as the imbalance of applications and enrollment might suggest, but is still significant.

In view of the uncertainty of the economy and of continued employer demand, not all qualified applicants should necessarily be accommodated. If a total of about 500 additional new students a year enrolled, it would mean an increase of some 7 percent over the 7,824 first-time students reported by New York engineering colleges to the EMC. This would amount to approximately 8,300 first-year engineering students a year enrolled in New York by 1985. Assuming that degrees four years later were awarded to about 70 percent of the freshman class, as they have been since 1975, there would be about 5,800 degrees in 1989, or 16 percent more than the 1980 figure of 4,990. This amounts to an increase in degrees of roughly 2 percent per year, compared to increases of 6 to 9 percent between 1977 and 1980. Clearly, the large increases of recent years cannot be maintained without an expansion in capacity of a magnitude which economic growth seems unlikely to justify.

The student demand clearly indicates an unserved market of potential engineering students, arguing for some expansion of capacity. Since demand for study of engineering seems fairly responsive to the job market, if a modest shortage (either national or State)

continues, demand for access is likely to remain strong. Under these circumstances, a modest expansion of the State's total capacity to provide undergraduate study in engineering appears to be a responsible course.

In making this recommendation the Department is assuming that applications to engineering programs will remain high. In view of the projected decline in the college-age population, this will necessarily mean a corresponding drop in enrollments in other areas.

Graduate Programs

Recommendation 2. *The Regents recommend an immediate, limited expansion of opportunities for part-time graduate education for the employed engineer, particularly in areas of high industry concentration.*

Rationale: The typical educational pattern for a practicing engineer is to continue study at the graduate level on a part-time basis while working full-time. Generally, such study culminates in an M.S. degree in an engineering discipline. Such a pattern can be followed by the working engineer only if part-time graduate study is offered reasonably nearby.

These needs are to some extent being met by off-campus programs in several areas of the State that have significant engineering employment but are beyond commuting distance of the main campus of an engineering school. Although such programs are of benefit, the difficulty of student advising and the limited accessibility of main-campus faculty are inherent drawbacks. An alternative is the establishment of graduate engineering programs on the campus of an institution located in such an area; such programs might be designed in cooperation between the local institution and one currently offering off-campus engineering education in the area. The costs of establishing new engineering programs are substantial; they must be weighed against the benefits which on-campus engineering education would afford for industries and employees.

Maintaining and Enhancing Quality

Recommendation 3. *The Regents recommend that New York State encourage programs of industry-university cooperation to alleviate both the faculty shortage and the problem of obsolete equipment in engineering colleges.*

Rationale: By fostering the exchange of ideas between university faculty and industry personnel, this policy can provide economic benefit to the State, as well as enhancing research opportunities for faculty and, through them, for their graduate students. Encouragement for programs of industry-university cooperation might include (but need not be limited to) favorable State tax policies affecting participating industries. Such programs would include the "loan" of Ph.D. engineers with industry experience in their fields to teach part- or full-time at New York colleges and universities, the partial underwriting of faculty costs by industry, the sharing of industry facilities with university research faculty, and similar arrangements.

Recommendation 4. *The Regents recommend, as one means of making the teaching of engineering a more attractive career, that alternatives to enhance faculty salaries be examined.*

Rationale: According to the Department's survey and the 1981 survey conducted by the Assembly Task Force on University-Industry Cooperation, faculty vacancy rates at New York's engineering schools have been somewhat lower than rates in the country as a whole but are on the rise. Engineering faculties appear to be aging, moreover, which argues that we will face a growing demand to replace retirees, if enrollments remain relatively strong. Our survey indicates that vacancies tend to be concentrated in the lower faculty ranks; this indicates that the problem is one (a) of attracting new faculty and (b) of retaining junior faculty.

A major element of the problem is the small number of Americans earning doctorates in engineering. Salaries paid new baccalaureate engineers by industry are a very powerful incentive to enter the work force rather than contemplate four or more years of graduate study and a faculty career.

One approach being given some consideration is differential salary schedules. Nationwide, of course, different salary schedules for the different schools at an institution are not uncommon. Last year, the University of California decided to provide for higher salaries in schools of business and engineering than in other schools; the Kansas legislature recently voted a similar program.

Other means of augmenting the attractiveness of engineering faculty positions are addressed in subsequent recommendations.

Recommendation 5. *In order to lighten the burden which capacity or above-capacity enrollments are imposing upon engineering faculty members, the State should adopt programs which would increase both the number and the financial stipends of teaching assistantships in engineering schools which offer graduate programs.*

Rationale: The Department survey revealed that increased class size and student-faculty ratios are increasing the incidence of faculty "burnout." This recommendation would have the additional benefit of increasing the supply of future faculty members in engineering.

Recommendation 6. *In addition to teaching assistantships, the State should establish a program of substantial graduate fellowships for full-time students in doctoral-level engineering programs.*

Rationale: By attracting capable students to continue toward a doctorate, this step would lead to an increased supply of future faculty members to fill the vacancies on engineering faculties (reported on the Department survey as 6.8 percent of full-time faculty positions in 1981-1982).

A possible model for such fellowships is the proposal made in October 1981 by the Commission on Independent Colleges and Universities for a number of "DeWitt Clinton Graduate Fellowships" in science and engineering. The CICU proposal calls for New York State to match industry funding raised by engineering schools for tuition and stipends for up to three years' graduate study.

Recommendation 7. *Centers for Advanced Technology, described in the Regents 1982 Legislative Proposals, should be authorized by legislation and funded. Each Center would operate within a designated technological field selected by the Regents in consultation with the New York State Science and Technology Foundation and the State's scientific, engineering and industrial, and business communities.*

Rationale: The Centers would enhance their host institutions' attractiveness for science and engineering faculty of high caliber, as well as providing further incentives for graduate study, by providing five additional Albert Einstein Chairs, plus funds for research facilities, equipment, graduate research fellowships, and support staff. In addition, the research performed at the Centers would stimulate the economic development of the surrounding areas.

Recommendation 8. *Research Equipment Acquisition Grants, described in the Regents 1982 Legislative Proposals, should be authorized by legislation and funded. Further, the State should seek to determine the dimensions of the acknowledged need for additional engineering laboratory equipment for both instructional and research purposes and initiate additional programs to help meet that need.*

Rationale: The Regents recognize that a critical problem exists regarding the adequacy of, and additional need for, engineering laboratory equipment in New York Colleges and universities. In response to earlier indications of that need they have included in their 1982 Legislative Proposals a program of competitive grants to help support new research equipment. Under this program, colleges and universities would (1) submit proposals for new research equipment acquisition and (2) seek funds from industry and other sources to match State funding awarded on a competitive basis. The proposal calls for a State appropriation of $5 million for the first year and for termination of the program after five years unless it is extended by legislation.

Obsolescent laboratory equipment emerged from the Department survey as a substantial problem for New York's engineering colleges. Seventeen institutions responding to this question on the survey estimated that over 32 percent of their laboratory equipment would need to be replaced at a cost of $18.5 million; in addition, they estimated the cost of additional equipment needed to support existing programs at $39.6 million - a total of $58.1 million to bring engineering laboratories up to date. An additional $2.8 million yearly was estimated as the amount needed to maintain laboratory equipment at an adequate level. These are large sums. If further practical steps are to be taken to assist institutions in maintaining up-to-date instructional and research laboratory equipment, the magnitude of the need must first be assessed in order to ascertain an appropriate level of State response.

Recommendation 9. *The Department shall continue its vigorous efforts to ensure the quality of engineering education programs in New York.*

Rationale: The Regents are mindful of the considerable existing investment by the State in engineering education and the additional investment that is implicit in several of these recommendations. Accordingly, it is incumbent upon the Education Department to continue to monitor the quality of the nearly 650 programs in engineering in New York. In this responsibility the Department must continue to work closely with the national accrediting body in engineering, the Accreditation Board for Engineering and Technology.

In conducting programmatic reviews, staff must be alert to emerging trends and developments so that issues (such as the aforementioned shortages of qualified faculty and up-to-date equipment) that go beyond individual institutions can be identified and addressed in a larger context.

Notes

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[3]"The Doctoral Shortage in Engineering: A Growing Crisis," unpublished report prepared by Russell McGregor for the National Association of State Universities and Land-Grant Colleges, May 18, 1981, pp. 1-2.

[4]Science and Engineering Personnel: A National Overview, National Science Foundation Report NSF 80-316 (Washington, D.C., June 1980), p. 5. Hereafter cited as "NSF 80-316."

[5]Cited in Manpower Comments, a journal published 10 times per year by the Scientific Manpower Commission, Washington, D.C., (December 1981), p. 6.

[6]NSF 80-316, p. 5.

[7]"Employment of Scientists and Engineers Increased between 1976 and 1978 but Declined in Some Science Fields," National Science Foundation, Science Resources Studies Highlights, NSF 80-305 (Washington, D.C., March 19, 1980), p. 5.

[8]"Science Resource Studies Highlights," NSF 81-331 (February 1982). Cited in Manpower Comments (March 1982), p. 10.

[9]The Endicott Report 1980 (Evanston, Ill.; Northwestern University, 1979), p. 3.

[10]Manpower Comments, (July-August 1981), p. 1.

[11]Cited in Manpower Comments (January-February 1982), p. 3.

[12]"Where Jobs Will Be for June Graduates," US News & World Report (January 25, 1982), pp. 73-74.

[13]Cited in Manpower Comments (March 1982), p. 1.

[14]NSF 80-316, p. 7.

[15]1980 Professional Income of Engineers, Engineering Manpower Commission of the American Association of Engineering Societies (New York, November 1980), p. 11.

[16]CPC Salary Survey 1981, cited in Science (September 25, 1981), p. 1. Yearly averages were obtained by multiplying monthly averages reported in the article by 12.

[17]The Chronicle of Higher Education (May 5, 1982), p. 4.

[18]McGregor, "The Doctoral Shortage," p. 4.

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[20]Leonard Silk, "Waiting for Recovery," New York Times (April 9, 1982), D2.

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[22]Manpower Comments (January-Feburary 1982), p. 7.

[23]"Science Resource Studies Highlights," NSF 81-321 (December 1981). Cited in Manpower Comments (January-Feburary 1982), p. 8.

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[25]Reported in Manpower Comments (November 1981), p. 5.

[26]Manpower Comments (April 1982), p. 3.

[27]Manpower Comments (January-February 1982), p. 3.

[28]Scientists, Engineers, and Technicians in Private Industry, National Science Foundation Report NSF 80-320 (1981). Cited in Manpower Comments (June 1981), p. 8.

[29]U.S. Scientists and Engineers 1978: Detailed Statistical Tables, National Science Foundation Report NSF 80-304 (Washington, D.C., 1980), pp. 19-20.

[30]Andrew Pollack, "A New Automation To Bring Vast Changes," New York Times (March 28, 1982), sec. 12, p. 1.

[31]"Development of High Technology Industries in New York State," Phase I Report (January 27, 1981), pp. 3-4.

[32]Regional Industrial-Technical Education Council of Long Island, Inc.," A Strategic Plan for New York State To Promote High Technology Development: An Industrial-Educational Perspective" (December 21, 1981).

[33]National Center for Higher Education Management Systems, "An Assessment of the Educational Needs of High-Technology Industries in the Area Served by the State University of New York at Binghamton, with Recommendations," p. 34.

[34]Ibid., pp. 34-36.

[35] Betty M. Vetter, Supply and Demand for Scientists and Engineers, 2nd Ed. (Washington, D.C.: Scientific Manpower Commission, January 1982), pp. 38-39.

[36] Max L. Carey, "Occupational Employment Growth through 1990," Monthly Labor Review (August 1981), p. 43.

[37] SUNY, "Investment Needs: Engineering and the Engineering Technologies" (January 26, 1982), pp. 7-8.

[38] Vetter, Supply and Demand, pp. 13-14.

[39] Engineering Manpower Commission, "Placement of Engineering and Technology Graduates 1980" (December 1980), p. 2. (Figures given count as employed 3 percent of bachelor's degree recipients and doctorates and 2 percent of master's degree recipients who were considering job offers when their placement officers were surveyed.)

[40] McGregor, "The Doctoral Shortage," pp. 1-2.

[41] NCHEMS, "An Assessment of the Educational Needs of High-Technology Industries in the Area Served by the State University of New York at Binghamton, with Recommendation," pp. 34-35.

[42] Ibid., pp. 37-38.

[43] Reported in Barnaby J. Feder, "The Marketplace in Four Major Fields: Engineering," New York Times National Recruitment Survey (October 11, 1981), pp. 17-18.

[44] NSF 80-316, pp. 16-17.

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[47] Figures for 1970 and 1979 are from the National Center for Education Statistics and National Research Council report, Degrees Awarded to Women: 1979 Update, by George H. Brown, as cited in Manpower Comments (July-August 1981), p. 20. The 1980 figure was computed from data supplied in the EMC report, Engineering and Technology Degrees 1980.

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[49] Survey by the Chemical Engineering Education Projects Committee of the American Institute of Chemical Engineers, reported in Manpower Comments (November 1980), pp. 8-9.

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[52]A Century of Doctorates: Data Analyses of Growth and Change (Washington, D.C., 1978), p. 79.

[53]Vetter, "Women Scientists and Engineers," p. 1313.

[54]"More than 1,600 Faculty Positions . . . ," The Chronicle of Higher Education (November 25, 1981), p. 10.

[55]"Faculty Salaries for 1981-82 by Rank and Discipline," The Chronicle of Higher Education (November 18, 1981), p. 14.

[56]"Inflation Tempers Salary Increases for Scientists and Engineers," Higher Education Daily (November 3, 1981), p. 6.

[57]McGregor, "The Doctoral Shortage," p. 3.